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CONTENTS

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NOTICE

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CONTENTS

NOTES AND REVIEWS

Distributional and other notes on some fresh-water prawns (Atyidae and Palaemonidae) mainly from the Indo-West Pacific region

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(Received July, 1961)

INTRODUCTION

THIS PAPER is based mainly on miscellaneous observations made in various European museums whilst the author was holding a grant of study leave from the University of Singapore. The principal results of these studies are embodied in other papers to be published elsewhere. I wish to record my thanks to the staff and authorities of: the British Museum (Natural History), the Cambridge University Zoology Museum, the Zoological Museum, Amsterdam, and the Rijksmuseum van Natuurlijke Historie, Leiden. My thanks are especially due to Dr. I. Gordon and Mr. R. Ingle of the British Museum (Natural History), and Dr. L. B. Holthuis of Leiden for specialist assistance and criticism. This work was only possible because of the financial assistance and leave of absence granted by the Council of the University of Singapore.

PALAEMONIDAE

Macrobrachium idae (Heller), 1862.

=*Palaemon idae* Heller, 1862, p. 416.
Palaemon (Eupalaemon) ritsemae De Man, 1897, p. 774.
? Palaemon delagoae Stebbing, 1915, p. 74.
? Palaemon (Eupalaemon) delagoae Barnard, 1950, p. 776.
Macrobrachium idae Holthuis, 1950, p. 142.

Material examined.—9 specimens in the collections of the British Museum, the Amsterdam Museum and the University of Singapore. Size from 44.2 to 87.5 mm., including an ovigerous female of 73.5 mm.

General notes.—The largest of these specimens differs from Holthuis's description in possessing a row of tubercles on either side of the cutting edge of each finger of the 2nd legs. This feature recalls the conditions found in the closely related *M. mamillodactylus*. Holthuis has informed me verbally that he has recently observed the same feature in other large specimens of *M. idae*.

In his key, Holthuis groups *M. idae* with those species in which the carpus of the second legs is longer than the chela. This is usually only true of very large individuals. The majority of adult specimens seem rather to correspond with the *ritsemae* form in which the carpus is not as large as the chela. In my opinion the form of the rostrum provides a much more satisfactory basis on which to distinguish this species from its allies.

Distributional notes.—Singapore and Kuching, Sarawak can now be added to the localities given by Holthuis. From the latter locality there is a specimen of 62.5 mm. derived from the Stebbing collection in the British Museum.

Holthuis lists a previous record from Singapore Island made by von Martens; but he considers that this record is doubtful. I have examined three specimens from Singapore. Two, in the collections of the University of Singapore, were taken in a fish-trap in the University pond, Bukit Timah Road. The third, a male of 75 mm., is in the Bedford-Lanchester collection in the British Museum and is labelled "freshwater, Tanglin, Singapore". The species thus appears to be well established, though uncommon, in this general district of Singapore Island. Recently I have collected further specimens from the Sedili drainage area in South Johore.

Macrobrachium sintangense (De Man), 1898a.

Holthuis, 1950, p. 151; Johnson, 1960a, p. 177.

Material examined.—109 specimens in the Amsterdam Museum and 31 specimens in the Leiden Museum previously reported on by Holthuis (1950); 3 specimens in the Cambridge Museum recorded by Lanchester (1901) from the Tale Sap as *Palaemon nipponensis;* 9 specimens in the British Museum; over 30 specimens in the collections of the University of Singapore.

General notes.—I agree with Holthuis's conclusions as to the systematic assignation of the material on which he reported. Holthuis (1950) and Kemp (1918) had both concluded that Lanchester's specimens really belonged to the present species; but their decisions rested entirely on interpretation of Lanchester's short description. Re-examination of Lanchester's specimens removes any doubt as to their identity with *M. sintangense.*

Distributional notes.—M. sintangense has previously been recorded from a number of localities in Peninsular Thailand, N. Sumatra, Java, and Borneo. The British Museum collections contain specimens from Kokraam in Peninsular Thailand and in addition from Perlis and from Bukit Jerneh, Selangor, in Malaya. I have collected it near Jasin, Malacca, at several localities near Kuala Pilah, Negri Sembilan, Malaya, and in the Sedili drainage area in South Johore. It is most probably generally distributed throughout Malaysia where conditions are suitable, though not yet reported from South Sumatra or from most of Borneo. Johnson (1960a) gives a distributional map. The Johore locality was not known when this map was prepared.

M. sintangense is principally found in slow-flowing rivers, canals, and streams. In contrast to most species of the genus it seems to be more frequent in open and disturbed country than in forested areas.

Macrobrachium lanchesteri (De Man), 1911.

Holthuis, 1950, p. 139; Johnson, 1957, p. 62.

Material examined.—134 specimens in the Cambridge Museum, the material on which Lanchester based his records of *Palaemon paucidens;* 1 specimen from Penang in the British Museum; several hundred specimens in the collections of the University of Singapore.

General notes.—Palaemon paucidens of Lanchester is not the same species as *P. paucidens* De Haan. De Man re-named it *Palaemon lanchesteri.* In the largest of Lanchester's samples from Singorra there were 16 ovigerous females of lengths 32.7 to 42.0 mm. These show rather considerable variation in the numbers of rostral teeth, feature also shown by material from other localities. The rostral formula is $\frac{6-8}{3-5}$.

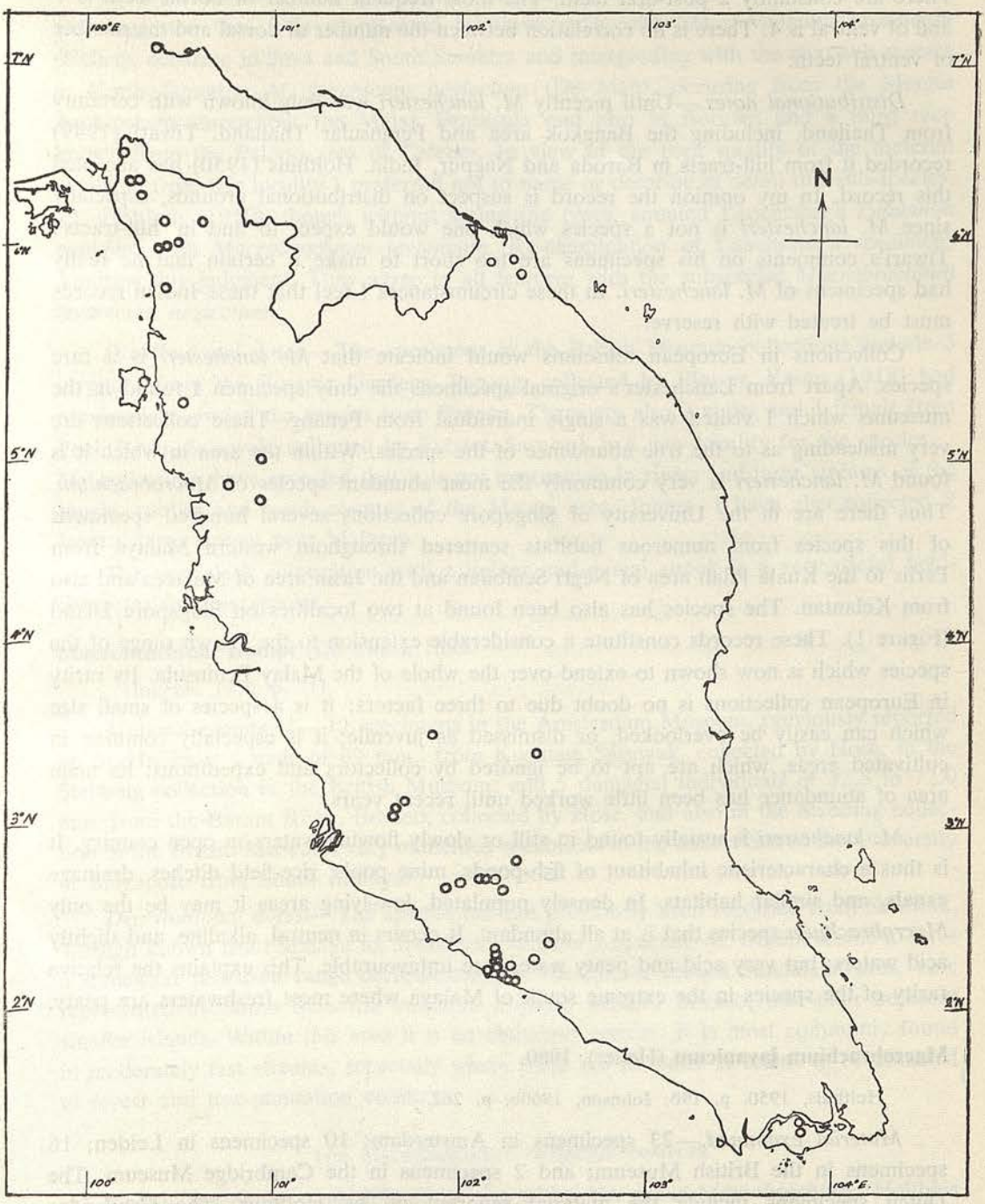


Figure 1. The distribution of *Macrobrachium lanchesteri* (De Man) in Malaya.

There are constantly 2 post-oral teeth. The most frequent number of dorsal teeth is 7 and of ventral is 4. There is no correlation between the number of dorsal and the number of ventral teeth.

Distributional notes.—Until recently *M. lanchesteri* was only known with certainty from Thailand, including the Bangkok area and Peninsular Thailand. Tiwari (1949) recorded it from hill-tracts in Baroda and Nagpur, India. Holthuis (1950) has accepted this record. In my opinion the record is suspect on distributional grounds, especially since *M. lanchesteri* is not a species which one would expect to find in 'hill-tracts'. Tiwari's comments on his specimens are too short to make it certain that he really had specimens of *M. lanchesteri*. In these circumstances I feel that these Indian records must be treated with reserve.

Collections in European museums would indicate that *M. lanchesteri* is a rare species. Apart from Lanchester's original specimens the only specimen I found in the museums which I visited was a single individual from Penang. These collections are very misleading as to the true abundance of the species. Within the area in which it is found *M. lanchesteri* is very commonly the most abundant species of *Macrobrachium*. Thus there are in the University of Singapore collections several hundred specimens of this species from numerous habitats scattered throughout western Malaya from Perlis to the Kuala Pilah area of Negri Sembilan and the Jasin area of Malacca and also from Kelantan. The species has also been found at two localities on Singapore Island (Figure 1). These records constitute a considerable extension to the known range of the species which is now shown to extend over the whole of the Malay Peninsula. Its rarity in European collections is no doubt due to three factors: it is a species of small size which can easily be overlooked, or dismissed as juvenile; it is especially common in cultivated areas, which are apt to be ignored by collectors and expeditions; its main area of abundance has been little worked until recent years.

M. lanchesteri is usually found in still or slowly flowing waters in open country. It is thus a characteristic inhabitant of fish-ponds, mine pools, rice-field ditches, drainage canals, and similar habitats. In densely populated, low-lying areas it may be the only *Macrobrachium* species that is at all abundant. It occurs in neutral, alkaline, and slightly acid waters; but very acid and peaty waters are unfavourable. This explains the relative rarity of the species in the extreme south of Malaya where most freshwaters are peaty.

Macrobrachium javanicum (Heller), 1960.

Holthuis, 1950, p. 190; Johnson, 1960b, p. 262.

Material examined.—23 specimens in Amsterdam; 10 specimens in Leiden; 16 specimens in the British Museum; and 2 specimens in the Cambridge Museum. The Dutch specimens include the material reported on by Holthuis. The Cambridge specimens are those which Lanchester (1901) referred to *Palaemon equidens*. In addition I have collected a moderate number of specimens from various localities in Malaya.

General notes.—I have previously commented on this species (Johnson, 1960b) and suggested that it is represented by three subspecies: *M. javanicum javanicum* (Heller), occuring in Java and South Sumatra and intergrading with the next sub-species in North Sumatra; *M. javanicum neglectum* (De Man), occuring from the Mergui Archipelago throughout the Malay Peninsula and also in Borneo; and a third race known from the Palopo area of Celebes. In view of the poor quality of the material available from this locality I preferred not to name or describe in detail this sub-species.

Holthuis (1950), though without seeing the types, equated Lanchester's *Palaemon equidens* with *Macrobrachium javanicum*. Re-examination of Lanchester's specimens confirms this judgment. They agree in all features with the subspecies *Macrobrachium javanicum neglectum*.

Distributional notes.—The specimens in the British Museum collections include 5 juveniles from the Botanic Gardens, Penang, collected by Flower. Kemp (1918) had previously recorded the species from Penang. There are also 9 males and 1 female from Poeh River, Sarawak, collected by Everett. Sarawak is a new locality for the species. My collections have revealed that it is not uncommon in rivers and large streams of the jungle, rubber and scrub country of the Mawai area, Johore. I have also collected it from a large stream near Malacca.

The very dark colouration with a lighter mid-dorsal streak is a very useful field-character for this species.

Macrobrachium trompi (De Man), 1898.

Holthuis, 1950, p. 211.

Material examined.—12 specimens in the Amsterdam Museum, previously reported on by Holthuis; 1 male of 69 mm., from Kuching, Sarawak, collected by Hose, in the Stebbing collection in the British Museum; and 5 damaged individuals of 52.5 to 72.0 mm. from the Baram River, Borneo, collected by Hose, and also in the Stebbing collection in the British Museum; very numerous specimens in the collections of the University of Singapore from South Malaya.

Distributional notes.—The species has not previously been recorded from Sarawak. Though known from Malaya its abundance was not suspected. *M. trompi* seems to have a somewhat restricted range corresponding to the former central Sundaland area, now represented by South Sumatra, southern Malaya, western Borneo, and their adjacent smaller islands. Within this area it is an abundant species. It is most commonly found in moderately fast streams, especially where there are leafbeds. It seems to be confined to forest and tree-plantation country.

The Macrobrachium pilimanus complex

This is one of the most difficult groups within the genus *Macrobrachium*. Holthuis (1950) submerged all forms of this complex in the single species *M. pilimanus*. After examining hundreds of specimens from many localities, and as a result of observations

in the field, I am convinced that this is an over-simplification. I have previously presented a preliminary analysis of the complex (Johnson, 1960b). In general I am still convinced of the soundness of this outline; but despite the wealth of material at my disposal it is still not possible to give a completely satisfactory analysis of all aspects of this complex assemblage of related forms. Following my previous treatment I am here recognizing three species: *M. pilimanus* (De Man), *M. leptodactylus* (De Man), and *M. malayanum* J. Roux. It is not unlikely, however, that further work, on more abundant material, combined with experimental work, may demonstrate that the Bornean forms referred to *M. leptodactylus* and *M. malayanum* represent distinct subspecies or even species.

Macrobrachium pilimanus (De Man), 1879.

=*Palaemon pilimanus* De Man, 1879, p. 181.

? Palaemon Miers, 1880, p. 384.

Palaemon pilimanus De Man, 1887, p. 4.

Palaemon pilimanus Ortmann, 1891, p. 735.

Palaemon (Macrobrachium) pilimanus De Man, 1892, p. 471.

Palaemon (Macrobrachium) pilimanus De Man, 1898, p. 158.

Palaemon (Macrobrachium) pilimanus Borradaille, 1900, p. 93.

Palaemon (Macrobrachium) pilimanus Hanitsch, 1900, p. 85.

Palaemon (Macrobrachium) pilimanus partim Nobili, 1900, p. 485.

Palaemon (Macrobrachium) pilimanus Nobili, 1901, p. 397.

Palaemon pilimanus partim Lanchester, 1901, p. 567.

Bythinis (Macrobrachium) pilimanus partim Rathbun, 1910, p. 317.

Palaemon pilimanus partim Koningsberger, 1913, p. 401.

Palaemon pilimanus Kemp, 1918, p. 267.

Palaemon (Macrobrachium) pilimanus Calman, 1925, p. 167.

Palaemon (Macrobrachium) pygmaeus J. Roux, 1928, p. 222.

Palaemon (Macrobrachium) pilimanus J. Roux, 1932, pp. 566 & 572.

Macrobrachium pilimanus Suvatti, 1937, p. 49.

Macrobrachium pilimanus Chace, 1938, p. 20.

Macrobrachium pilimanus partim Holthuis, 1950, p. 214.

Macrobrachium pilimanus Holthuis, 1956, p. 67.

Macrobrachium pilimanus Johnson, 1960b, p. 265.

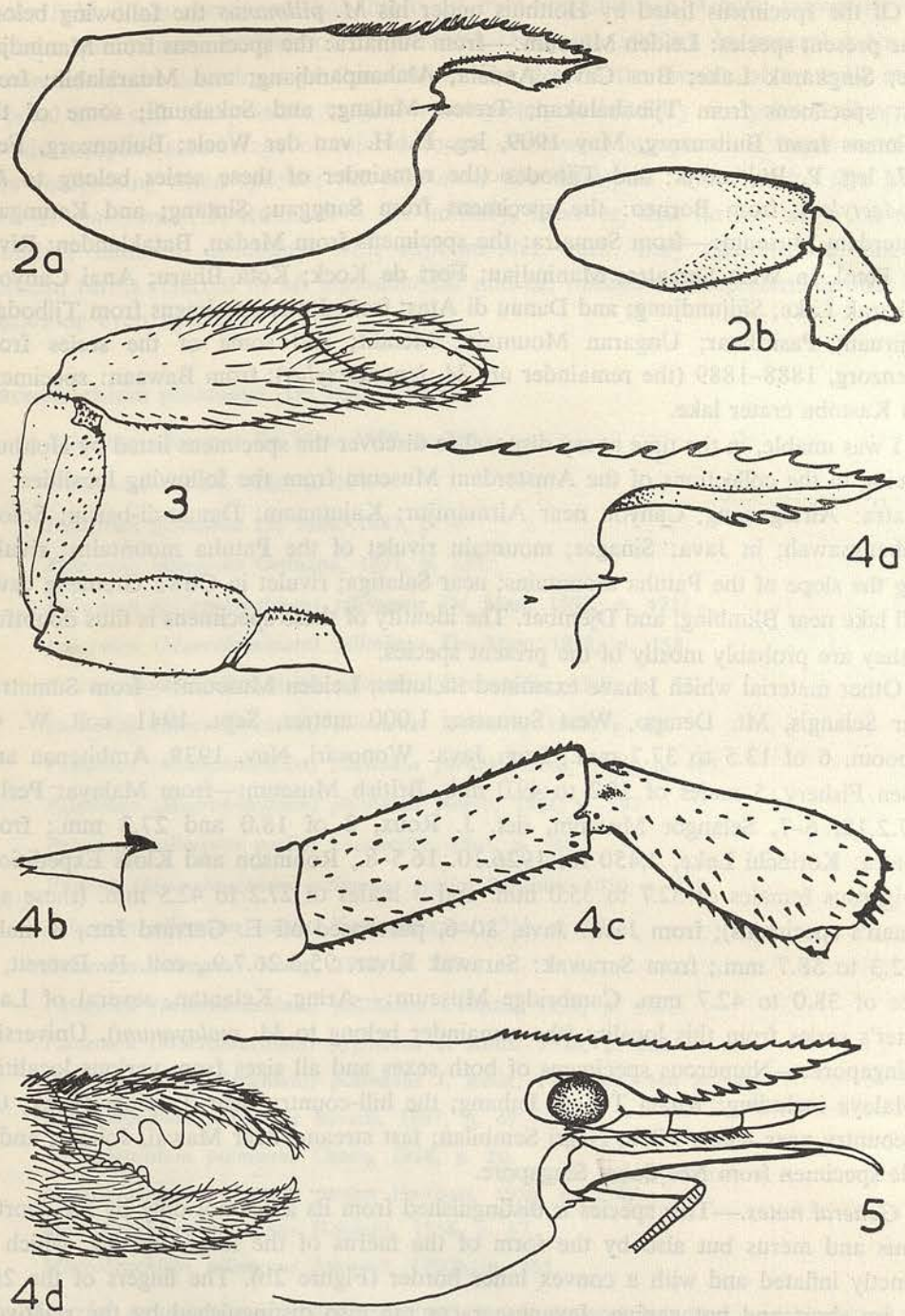
Material examined.—I have examined in all several hundred specimens of this species, including most of the material assignable here which was reported on by Holthuis.

Of the specimens listed by Holthuis under his *M. pilimanus* the following belong to the present species: Leiden Museum:—from Sumatra: the specimens from Manindjau Lake; Singkarak Lake; Bua Cave; Andala; Alahanpandjang; and Muaralabih; from Java: specimens from Tjibabalukan; Tretes; Malang; and Sukabumi; some of the specimens from Buitenzorg, May 1909, leg. H. H. van der Weele; Buitenzorg, Feb. 1927, leg. P. Buitendijk; and Tjibodas (the remainder of these series belong to *M. leptodactylus*); from Borneo: the specimens from Sanggau; Sintang; and Ketungau. Amsterdam Museum:—from Sumatra: the specimens from Medan, Bataklanden; River near Petok in West Sumatra; Manindjau; Fort de Kock; Kota Bharu; Anai Canyon; Singkarak Lake; Sidjundjung; and Danau di Atas; from Java: specimens from Tjibodas; Tjinjiruan; Pasirdatar; Ungaran Mountain; Mendit; and some of the series from Buitenzorg, 1888–1889 (the remainder are *M. leptodactylus*); from Bawean: specimens from Kastoba crater lake.

I was unable, in the time at my disposal to discover the specimens listed by Holthuis as being in the collections of the Amsterdam Museum from the following localities: in Sumatra: Airteganang; Canyon near Airmantjur; Kajutanam; Danau-di-barun; Solok; Tambangsawah; in Java: Sinagar; mountain rivulet of the Patuha mountains; rivulet along the slope of the Patuha mountains; near Salatiga; rivulet in Guwa Gremeng cave; small lake near Blimbing; and Djember. The identity of these specimens is thus doubtful; but they are probably mostly of the present species.

Other material which I have examined includes, Leiden Museum:—from Sumatra: River Selangis, Mt. Dempo, West Sumatra, 1,000 metres, Sept. 1941, coll. W. C. Verboom, 6 of 13.5 to 37.7 mm.; from Java: Wonosari, Nov. 1938, Ambitenaa and Binnen Fishery, 5 males of 35.2 to 49.0 mm. British Museum:—from Malaya: Perlis, 1937.2.12. 6–7, Selangor Museum, det. J. Roux, 2 of 18.0 and 27.3 mm.; from Sumatra: Korinchi Lake, 2,450 ft., 1926.10. 16.5–8., Robinson and Kloss Expedition, 3 ovigerous females of 32.7 to 35.0 mm. and 3 males of 27.2 to 42.5 mm. (these are Calman's specimens); from Java: Java, 80–6, purchased off E. Garrard Jnr., 3 males of 32.3 to 58.7 mm.; from Sarawak: Sarawak River, 95.3.26.7.9., coll. R. Everett, 4 males of 38.0 to 42.7 mm. Cambridge Museum:—Aring, Kelantan, several of Lanchester's series from this locality (the remainder belong to *M. malayanum*). University of Singapore:—Numerous specimens of both sexes and all sizes from various localities in Malaya including: Kuala Tahan, Pahang; the hill-country near Taiping, Perak; the hill country near Kuala Pilah, Negri Sembilan; fast streams near Mawai, Johore; and a single specimen from Nee Soon, Singapore.

General notes.—This species is distinguished from its allies not only by the shorter carpus and merus but also by the form of the merus of the large 2nd leg, which is distinctly inflated and with a convex inner border (Figure 2b). The fingers of the 2nd legs are short and not gaping. Javanese races are also distinguished by the relatively small number (normally 3 to 4) of post-orbital rostral teeth; but this distinction breaks down when individuals from other areas are considered.



Figures 2–5. 2. *Macrobrachium pilimanus,* male of 39.5 mm, Sarawak River, Borneo, (*a*) carapace and rostrum, (*b*) merus and carpus of large second leg. 3. *Macrobrachium* cf. *leptodactylus,* large second leg of male of about 46.2 mm, Kajan River, Borneo. 4. *Macrobrachium geron,* Singapore, (*a*) rostrum and anterior region of carapace of male of 53.8 mm, (*b*) antennal and hepatic spines of juvenile, (*c*) merus and carpus of large second leg of male of 53.8 mm, (*d*) end of chela of large second leg of male of 52.0 mm. 5. *Caridina simoni peninsularis,* female of 27.8 mm, Tanglin, Singapore, rostrum and anterior portion of carapace.

Distributional notes.—This is the commonest and most widely distributed member of the complex (Johnson, 1960b, fig. 4, p. 264). Records indicate that it occurs throughout Malaya, Sumatra, Java, and Borneo, wherever conditions are suitable. Holthuis (1950), dealing with the complex as a whole, states that it is found at altitudes of between 250 and 2,500 metres. The upper limit presumably varies from country to country. In Malaya it would, of course, be impossible for the species to attain a height of 2,500 metres. The actual upper limit in Malaya is much lower. Good negative evidence indicates that no prawns occur in Malaya at heights much in excess of 4,000 ft. (approximately 1,200 metres). On the other hand, in Malaya, *M. pilimanus* descends to much lower levels than 250 metres. The rivers at Kuala Tahan, where the species is abundant are at a height of about 100 metres, whilst the localities where I have collected it in South Johore are for the most part at heights of less than 100 metres. The single specimen from Singapore was taken almost at sea-level; but the species is certainly not established in this locality.

In my opinion height above sea-level is not in itself a very important factor in determining the distribution of *M. pilimanus*. It appears to be so because it is to some extent correlated with other habitat features, which do influence the occurence of the species. *M. pilimanus* is essentially an inhabitant of torrential, or near torrential, streams and rivers which lie in jungle country or thinly settled tree-plantation country.

These requirements are most often met with in highland areas, especially where, as in Java and much of Sumatra, the lowlands are densely populated and much cultivated. The exact factors responsible for this limitation to shaded, unpolluted, fast streams are not as yet known. Temperature, especially the need for a constant temperature, may be of some importance; oxygen content of the water is almost certainly important. In this connection, it is significant that in addition to torrent streams and rivers, the species is known from well-oxygenated lakes.

Macrobrachium pilimanus is in many ways less well-adapted to torrent life than are such species as *Atya spinipes*. It does not occur in the fastest parts of torrential streams and rivers. This has probably prevented it from reaching a number of otherwise suitable habitats, such as the streams of the Cameron Highlands in Malaya.

Macrobrachium leptodactylus (De Man), 1892.

=*Palaemon (Macrobrachium) pilimanus leptodactylus* De Man, 1892, p. 476, pl. 28, figs. 44i to 1.

Palaemon (Macrobrachium) pilimanus partim De Man, 1892, p. 471.

Bythinis (Macrobrachium) pilimanus partim Rathbun, 1910, p. 317.

Palaemon pilimanus partim, Koningsberger, 1913, p. 401.

Macrobrachium pilimanus partim Holthuis, 1950, p. 214.

Macrobrachium leptodactylus Johnson, 1960b, p. 265.

Material examined.—The following specimens mentioned by Holthuis (1950) must be referred to the present species: Leiden Museum:—from Java: Buitenzorg, 1888–1889, leg. M. Weber, cotypes of *Palaemon pilimanus leptodactylus* De Man; Buitenzorg, May 1909, leg. H. H. van der Weele, some of series; from Borneo: near the source of the Kajan River, some of the series. Amsterdam Museum:—from Sumatra: specimens from Taluk, Central Sumatra; from Java: Buitenzorg, 1888–1889, leg. M. Weber, cotypes of *Palaemon pilimanus leptodactylus* De Man; Buitenzorg, 1888–1889, West Java, leg. M. Weber.

The Bornean specimens may not belong to this species (see below). No further specimens are known to me.

General notes.—M. leptodactylus can be distinguished from *M. pilimanus* by the long carpus which is either conical or sub-cylindrical; by the moderately long fingers, which show a slight gape in both 2nd legs; and by the non-inflated merus of both second legs. In Javanese and Sumatran specimens there are 5 to 6 post-orbital teeth as opposed to the 3 to 4 normally characterizing *M. pilimanus* from these areas. In Borneo this distinction unfortunately breaks down since true *M. pilimanus* from Borneo has usually 5 or 6 post-orbital teeth.

Whilst these differences are very slight they are quite sufficient to characterize the two species, though careful examination is required where only one species is known from a given habitat. Where the two forms occur together they are always quite distinct and there are no intermediates. In these circumstances two species must be recognized, despite the practical difficulties which this involves.

Whilst *M. pilimanus* and *M. leptodactylus* are effectively isolated, it is possible that a small amount of introgressive hybridization may occasionally occur between them. This possibility is indicated by the close general resemblance commonly shown by individuals of the two species obtained from the same habitat. Other explanations, such as ecophenotypic modifications and similar response to similar selection pressure, may also give this effect so that the occurence of introgressive hybridization remains no more than a possibility on the evidence available.

I have some doubts as to the identity of the Bornean specimens which I have referred to the present species. They agree with *M. leptodactylus* in the size and general form of the second legs. The merus of the large second leg is very slightly inflated; but it is much closer to the form found in *M. leptodactylus* than that found in *M. pilimanus*. In other features they differ rather strikingly from both *M. pilimanus* and *M. leptodactylus*. The 2nd legs are more spinescent than is usual in either of these species, and the fingers of the large 2nd leg are short and widely gaping (Figure 3). The dactylus only bears about 5 teeth which are rather large and uniformly distributed. It seems probable that future work will show that this Bornean form represents a distinct sub-species or even species.

Distributional notes.—This species seems to be much less common than *M. pilimanus*. It is chiefly known from Java with one known locality (Taluk) in central Sumatra. Individuals which may belong here, as mentioned above, are known from the Kajan river in Borneo. The species is apparently absent from Malaya. Johnson (1960b, figure 4, p. 264) has figured this distribution.

Macrobrachium malayanum (J. Roux), 1934.

=*Palaemon pilimanus* partim Lanchester, 1901, p. 567.
Palaemon (Macrobrachium) pilimanus malayanus J. Roux, 1934, p. 32.
Macrobrachium pilimanus partim Holthuis, 1950, p. 214.
Macrobrachium malayanum Johnson, 1960b, p. 265.

Material examined.—Cambridge Museum:—several of a series of 10 specimens from Aring, Kelantan, Malaya; the specimens are badly fragmented so that it is not possible to be certain how many belong here and how many to *M. pilimanus*, to which they were assigned by Lanchester, but both species are represented; one damaged

specimen from Belimbing, Malaya, also reported on as *M. pilimanus* by Lanchester. University of Singapore:—numerous specimens from the Tahan River near Kuala Tahan, Pahang.

Doubtfully assigned here is the specimen from the Upper Sibau River reported on by Holthuis (1950).

General notes.—On the basis of Roux's description, Holthuis (1950) concluded that Roux's subspecies was identical with *Macrobrachium pilimanus*. Whilst I have not been able to examine Roux's type specimens it is clear from his description that the form he had is the same as that which I have from other Malayan localities. Unfortunately Roux does not fully bring out the great differences which exist between *M. malayanum* and typical *M. pilimanus*. In *M. malayanum* the merus of the large 2nd leg is not inflated, the carpus is moderately elongate though less so than in *M. leptodactylus,* and is sub-cylindrical in shape; the palm is slender and sub-cylindrical in shape; and the fingers, which are much longer than the palm, are slender and widely gaping. The fingers of the small 2nd leg are similarly slender and widely gaping, but the palm, as Roux states, is relativcly broader. In Roux's specimen the fingers of the large second leg are said to be a little shorter than the palm. This is probably a local or age difference. The pubescence of *M. malayanum* is longer than that of *M. pilimanus*. The basal joints of the 2nd legs are provided with larger spines. As Roux has previously pointed out the rostrum is less convex dorsally and less high than that of *M. pilimanus*.

The specimen from the Upper Sibau River, S. W. Borneo which Holthuis (1950) records as *M. pilimanus* certainly does not belong to *M. pilimanus* s.s. Only the small 2nd leg remains which makes identification rather difficult. The specimen closely resembles specimens of *M. malayanum* and may well belong to that species; but the fingers of the small 2nd leg are even more gaping and proportionally even longer than is usual in *M. malayanum*. The systematic position must therefore remain doubtful until further material is available.

Distributional notes.—*M. malayanum* is known from the Aring River; Belimbing; Lasah; and the Sungei Tahan in Malaya. All these are fast-flowing rivers in mountainous regions of northern and north-central Malaya. It possibly also occurs in similar areas in S.W. Borneo. It is not known from Sumatra or Java.

Macrobrachium scabriculum (Heller), 1862.

Holthuis, 1950, p. 224.

=*Palaemon dolichodactylus* Barnard, 1950, p. 779.

Material examined.—Leiden Museum:—8 specimens previously reported on by Holthuis. British Museum:—Kenya: Sabaki River, 1955.1.24.12 & 1955.1.24. 10–11, coll. Hugh Copley, numerous specimens; Sabaki and Tana Rivers 1948, and 1951.4.16.7–20, coll. W. E. Frost; Madagascar: Madagascar, 1914.6.11.16–19, Transvaal Museum, originally labelled as *P. (Parapalaemon) dolichodactylus,* 3 males circa 2.4 to 3.54 inches and 1 ovigerous female of 1.96 inches; Pakistan: Indus River, Kotree, no. 110, Karachi Museum, 7 of 1.22 to 2.10 inches of which the two largest are males; India: Madras, 89.6.17, coll. F. Day, 3 males of 2.82 to 3.12 inches; Malaya: freshwater, Tanglin, Singapore, ref II 14, & 5.3.99. Bedford-Lanchester collection, 5 of 28 to 38 mm.

General notes.—Despite his doubts I consider that Holthuis's synonymy of this species is correct. The Madagascar males have the general features of *M. scabriculum,* but the proportions of the carpus to the merus of the 2nd legs is as in *M. dolichodactylus.* The female is closely similar to the specimens from Singapore. These last correspond very well with Henderson and Mathai's description of *Palaemon dubium.* They differ from descriptions of *Macrobrachium scabriculum* in lacking special pubescence on the carapace and the palm of the 2nd legs, and in the lack of teeth on the fingers distal to the largest tooth of the proximal set. In my opinion these are juvenile characters and it is significant that the two largest Singapore specimens show indications of the beginnings of these teeth and of pubescence on the second legs.

Distributional notes.—Of the new records given that from Madras falls well within the known range of the species. The Kenya records help to fill the gap in known localities between Tanganyika and Italian Somaliland. The Singapore specimens represent an important extension of the known range of the species. Its previous known eastward limits were N. Sumatra and Enganno. The species appear thus to be widely distributed around the Indian Ocean from Madagascar and East Africa through to Malaya and Sumatra. It is clearly very rare in the most south-eastern portion of its range.

I have never collected this species in Singapore: when collected by Bedford and Lanchester it was apparently associated with *Macrobrachium idae* and *Caridina brachydactyla peninsularis,* specimens of both of which species were in the same bottle. The former still occurs in the Tanglin area but the latter has not been recorded there in recent years. It seems possible that *Macrobrachium scabriculum* may have been exterminated as a consequence of the increasing urbanization of the Tanglin area of Singapore, and thus may no longer occur on the island.

Macrobrachium latidactylus (Thallwitz), 1891.

Holthuis, 1950, p. 239.

Material examined.—Amsterdam Museum:—23 specimens previously reported on by Holthuis. Cambridge Museum:—the 2 specimens reported on by Lanchester (1901) as *Palaemon lampropus,* including an ovigerous female of 47 mm., Aring, Kelantan.

General notes.—Lanchester's specimens are both small and in bad condition. The larger specimen lacks all thoracic appendages behind the 1st legs. Nonetheless these can undoubtedly be assigned to *Palaemon lampropus,* which, as Holthuis has shown, is based on small specimens of *Macrobrachium latidactylus.*

Distributional notes.—The distribution of *Macrobrachium latidactylus* is distinctly puzzling. The species occurs in Peninsular Thailand and N.E. Malaya. It is not known from Sumatra, Java, or the rest of Malaya, despite intensive collecting in these areas. Neither is it known from Borneo. It re-appears in the Philippines and the eastern portion of the Indo-Australian Archipelago. Recent collections which I have made in eastern Malaya have revealed a somewhat similar distributional pattern in members of the *Macrobrachium weberi* complex.

Macrobrachium cf. **asperulum** (Von Martens), 1868.

Holthuis, 1950, p. 193.

=*Palaemon sundaicus* Lanchester, 1901, p. 568.

Material examined.—2 specimens of 29 mm. (ovigerous) and 25.5 mm. from R. Patalung, Thailand, in the Cambridge Museum, reported on by Lanchester (1901) as *Palaemon sundaicus*.

General notes.—Holthuis (1950) accepted Lanchester's records of *Palaemon sundaicus* and included them in the synonymy of *Macrobrachium equidens*. I have not been able to examine the specimens on which Lanchester's 1906 record was based, but I was able to examine those on which he reported in 1901. Size alone makes it clear that these cannot be *Macrobrachium equidens,* which is a large species. They also differ from that species in numerous other details. Comparison with described species reveals that they are at least very close to *M. asperulum*. Lanchester's description of the armature of the fingers is incorrect. The dactylus has 2 minute teeth and the fixed finger is unarmed.

In shape the rostrum agrees closely with that of specimens of *M. asperulum* from S. China. The rostral formula is $\frac{10-11}{4-5}$, with 2 or 3 post-orbital teeth, again agreeing with *M. asperulum*. The relative length of the rostrum is also as in Chinese specimens of *M. asperulum*.

The arrangement of the antennal and hepatic spines is as in *M. asperulum,* as is also the general form and length of the 2nd legs. Like that species these specimens have fine spinules on the carpus and palm, and the dentition of the fingers is identical. However the spinulation of the 2nd legs is rather feebly developed and I could not detect any keel on the carpus of the 2nd legs. These differences may be due to the small size of the specimens; but this is not certain. In the relative lengths of the dactylus and carpus of the posterior legs my specimens agree with those described by De Man and by Holthuis, but differ somewhat from the type description, as those authors have indicated.

Were these specimens from within the area known to be occupied by *M. asperulum* I would feel reasonably confident in assigning them to that species. Since, however, these specimens came from Patalung, Peninsular Thailand, and *M. asperulum* is a species of temperate eastern Asia there is a strong possibility that they may represent a new species closely related to *M. asperulum* but not identical with it. A decision on this point must await the collection of larger and better series from Peninsular Thailand or Malaya.

Macrobrachium geron Holthuis.

=*Macrobrachium geron* Holthuis, 1950, p. 258.

Material examined.—Leiden Museum:—Banka, coll. J. A. Buddingh, 1 male of 61.0 mm., the type specimen. British Museum:—Singapore, freshwater stream in Botanic Gardens, Bedford-Lanchester collection, no. 169, ref. II. 13, 18.11.99., 2 males of 52.0 and 53.8 mm.; Singapore, Bukit Timah, coll. C. S. Flower, 96.6.15., 13–16, 12 specimens of 14.8 to 39.5 mm. including an ovigerous female of 29.5 mm. University of Singapore:—Very many specimens ranging from small juveniles to full-grown males and females from Bukit Timah hill, Mandai Road, and Nee Soon swamp forest in Singapore, and from the north face of Gunong Pulai and the Mawai area in Johore.

General notes.—This species has previously been known only from a large male collected in Banka in 1867. Despite intensive collecting in Indonesia no further specimens have been recorded. It is therefore both surprising and gratifying to find that it is very common not only in South Johore, but also in parts of Singapore Island where it still persists despite the progressive urbanization of the island. Both Bukit Timah and the Nee Soon swamp forests lie in nature reserves, so that the future of the species in Singapore is reasonably assured.

The specimens from Malaya do show a few very slight differences from Holthuis's specimen and since they include juveniles they throw considerable light on age-variations in this species.

Holthuis describes the rostrum as reaching 'slightly beyond the middle of the third segment of the antennular peduncle'; but in his figure (52a) the rostrum is shown as slightly over-reaching the antennular peduncle. Re-examination of the type confirms the accuracy of Holthuis's figure as opposed to his description, though the antennular peduncle is slightly longer on one side than on the other and on this side it is almost as long as the rostrum. In almost all my specimens the rostrum is of the same length as in the type but in Flower's ovigerous female from Bukit Timah it is somewhat shorter and only attains the middle of the third segment of the antennular peduncle. In the type specimen the rostral formula is $\frac{11}{4}$ with $3\frac{1}{2}$ post-orbital teeth. Malayan specimens show general agreement with this formula but extend the range of variation, the rostral formula being $\frac{10\text{–}11}{3\text{–}4}$ with some 3 to 5 post-orbital teeth. The ventral teeth are more commonly 4 in number than 3. The rostral shape proves to be slightly variable. Some Singapore specimens have the rostrum even higher and more convex dorsally than Holthuis figures for the type. In other Malayan specimens the rostrum is more slender and almost or quite straight dorsally (Figure 4a).

In the largest Malayan specimens only the anterior portion of the carapace is scabrous, whereas in the type there is only a very small smooth portion in the posterior region (the carapace is not scabrous all over even in this specimen, contrary to the implications of Holthuis's description). Since the type is a very large male, distinctly larger than any Malayan specimen which I have seen, these differences are doubtless age-differences dependent on size. In smaller specimens the scabrosity of the carapace is reduced in extent and individuals of less than 40 mm. overall length have the carapace completely smooth. In the larger Malayan specimens the anterior portion of the carapace is covered by a short, sparse pubescence. This feature is not mentioned by Holthuis; but it is in fact found in the type. The hepatic spine is very anteriorly placed in young individuals (Figure 4b).

Malayan specimens agree exactly with the type in the structure of the abdomen, the telson, and the anterior appendages. In Singapore specimens the 1st pereiopod only over-reaches the antennal scale by $\frac{1}{3}$ not $\frac{1}{2}$ the length of the carpus.

Whilst the second legs of the larger Malayan males agree closely in form and structure with those of the type, they show some variations which are partly consequent on the smaller size of these specimens and partly true individual variation (Figures 4c & 4d).

As Holthuis notes the two second legs differ considerably in size. In the larger second leg the proximal joints are devoid of pubescence and are armed with large spines, which

tend to be arranged in regular longitudinal rows. The spines are towards the dorsal margin. The ventral and dorsal margins of the rectangular merus are almost straight. The rather short carpus is distinctly conical. Its length is somewhat variable, just as is the case in *M. pilimanus* and its allies. In the type the carpus is distinctly shorter than the merus and only about ½ as long as the palm. In adult Malayan specimens it seems always to be longer than ½ the palm and varies from being somewhat shorter than the merus to being as long as the merus. The chela is markedly compressed and it is rather high in proportion to its length. The fingers are short and the dactylus is very strongly curved. Unfortunately Holthuis's figure shows the chela of his specimen in a somewhat oblique view, so that some of its characteristic features are obscured. In this figure the palm appears to be of uniform height throughout. In fact in the type male as in the larger Malayan specimens the palm is slightly higher distally than proximally. In somewhat smaller specimens this feature is more pronounced and the palm tapers strongly towards the base. The curvature of the dactylus is also much more pronounced than appears from Holthuis's figure. The palm and fingers are covered with a dense brown pubescence, which is distinctly longer and more woolly in the type than in even the largest Malayan specimens. In addition, in the type, the entire palm and the basal portions of the fingers bear numerous small spinules. In the largest Malayan specimens spinules are present on the palm but they are absent from the base of the fingers. The dentition of the dactylus is very characteristic. The cutting edge bears 2 large teeth which divide it into three portions of approximately equal length. In addition there are 2 or 3 smaller teeth in the proximal portion. The dentition of the fixed finger is essentially similar. In the Singapore specimens, but not in the type, the proximal teeth of the fixed finger are partially fused to form a crenulated ridge.

The small second leg resembles in structure the large second legs of small individuals. Thus its structure is essentially the same as that of the large leg, differences being the direct result of its smaller size. As a consequence it is more slender and less compressed and the spinulation is less pronounced. There is no pubescence on the palm and fingers apart from some rather densely arranged setae along the inner margins of the fingers. The teeth on the fingers are rather feebly developed, though stronger than would appear from Holthuis's figure. They are confined to the basal portion. The fingers are only slightly gaping, the gape being no more marked than that shown by the fingers of the large leg. The carpus is relatively slightly longer than in the large leg. In the type it is about 2/3rds as long as the palm. In the larger Singapore males it is slightly shorter.

Unfortunately the variability in the carpus of the second legs renders Holthuis's key useless for the determination of this species. However the form of the large second leg is so characteristic that it cannot easily be misidentified if adult males are available. Holthuis associates *M. geron* with such species as *M. bariense* and *M. grandimanus* in which the fingers of the small second leg are distinctly gaping and the two second legs differ markedly in structure. In my opinion *M. geron* is in no way related to these species, but comes much closer to *M. pilimanus* and its near allies.

Distributional notes.—Previously only known from a single specimen from Banka, *M. geron* is now shown to be a common, and often a dominant, species in S. Malaya including Singapore Island. It is found in fast-flowing and even torrential streams, though it is less definitely a torrent prawn than is *M. pilimanus.*

ATYIDAE

Caridina gracilirostris gracillima Lanchester, 1901.

=*Caridina gracillima* Lanchester, 1901, p. 560, pl. IV fig. 1; Bouvier, 1925, p. 140.
Cardina gracilirostris partim Johnson, 1961, p. 124.

Material examined.—British Museum:—Tale Sap, Peninsular Thailand, 1919. 11.1.32–41, Indian Museum, coll. N. Annandale, January 1916, 22 specimens of 10.5 to 24.5 mm. including 5 ovigerous females of 21.8 to 24.3 mm., these presumably being some of the series reported on by Kemp. Cambridge Museum:—162 specimens from the extensive type series of Lanchester.

General notes.—In a previous paper (Johnson, 1961) I suggested on morphological grounds that *Caridina gracillima* Lanchester must be included within the species *C. gracilirostris* De Man. I have now been able to re-examine the very extensive type-series of *C. gracillima* as well as part, at least, of the material assigned here by Kemp.

It is clear that these do not differ in any essential characteristics from typical *C. gracilirostris,* with the exception of the shorter rostrum. The rostrum is, as Lanchester noted, much shorter than is usual in *C. gracilirostris* and this feature characterizes all the individuals of both species. Thus the very short rostrum would seem to be universal amongst the population of *C. gracilirostris* found in the Tale Sap and its adjoining fresh and brackish waters. In view of this uniformity I now consider that it is appropriate to assign sub-specific standing to this form.

It is of interest that, with the exception of very few individuals of doubtful sex, all the adults in these two series are females. This preponderence of females is so nearly absolute that one feels bound to conclude that *C. gracilirostris gracillima* is parthenogenetic. This would account both for its divergence from the more typical form of the species and the low degree of variability shown by the Tale Sap populations.

Distributional notes.—*C. gracilirostris gracillima* appears to be confined to the Tale Sap and adjoining fresh and slightly saline waters. Here it replaces the typical sub-species.

Caridina gracilirostris gracilirostris De Man, 1892.

see Bouvier 1925, p. 142 and Johnson 1961, p. 124.

Material examined.—33 specimens in the Leiden Museum of 13.0 to 22.9 mm. excluding the rostrum; numerous specimens in the collections of the University of Singapore.

General notes.—Malayan specimens are not distinguishable from the typical subspecies, at least in so far as those from the south and west coasts are concerned though some individuals vary in the direction of *C. gracilirostris gracillima.* Specimens from Ceylon have the rostrum somewhat shorter than in the typical race, in this feature somewhat approaching *C. gracilirostris gracillima.* They may ultimately prove to belong to a distinct geographical sub-species; but in the absence of more extensive material I prefer to include them in the typical sub-species.

Distributional notes.—Specimens I have examined include, in addition to the type-series from Balangnipa, Celebes, a series of 27 specimens from Bolgoda, Ceylon. In addition I have specimens from various localities in Singapore including Nee Soon

and Paya Lebar (a single specimens in the Leiden Museum collected by Marshall Laird), various localities in North and South Johore, and from brackish swamps on Penang Island.

Caridina gracilirostris is essentially an inhabitant of low-salinity brackish waters, though it occasionally spreads out into adjoining fresh-waters and high salinity brackish waters. It is noticeably sporadic in occurence sometimes being present in large numbers in a habitat from which it may be almost completely absent at other periods.

Caridina simoni Bouvier, 1904.

=*Caridina Wyckii* De Man, 1892, p. 386.
not *Atya Wycki* S. I. Hickson, 1888, p. 957.
? *Caridina Wyckii* Henderson, 1893, p. 434.
? *Caridina Wyckii* Nobili, 1903, p. 6.
Caridina Simoni Bouvier, 1904, p. 130.
Caridina Wycki var. *gracilipes* J. Roux, 1904, p. 554.
not *Caridina Wycki* var. *gracilipes* De Man, 1892, p. 387.
Caridina Simoni Bouvier, 1905, pp. 73 & 80.
? *Caridina nilotica* var. *bengalensis* De Man, 1908, p. 265.
Caridina nilotica var. *brachydactyla* De Man, 1908, p. 269.
Caridina nilotica var. *gracilipes* Rathbun, 1910, p. 316.
Caridina aruensis J. Roux, 1911, p. 82.
Caridina Simoni Bouvier, 1912, p. 918.
Caridina brachydactyla Bouvier, 1913a, p. 463.
Caridina aruensis Bouvier, 1913a, p. 463.
Caridina Simoni Bouvier, 1913a, p. 463.
Caridina aruensis Bouvier, 1913b, p. 181.
? *Caridina nilotica* var. *bengalensis* Kemp, 1915, p. 307.
Caridina nilotica var. *gracilipes* J. Roux, 1917, p. 590.
Caridina brachydactyla subsp. *peninsularis* Kemp, 1918, p. 270.
Caridina nilotica var. *gracilipes* Kemp, 1918, p. 275.
? *Caridina nilotica* var. *bengalensis* Kemp, 1918, p. 275.
Caridina nilotica var. *gracilipes* partim Bouvier, 1925, p. 152.
Caridina nilotica var. *brachydactyla* Bouvier, 1925, p. 155.
Caridina nilotica var. *aruensis* Bouvier, 1925, p. 156.
Caridina nilotica var. *Simoni* Bouvier, 1925, p. 157.
Caridina nilotica var. *meridionalis* J. Roux, 1926, p. 207.
Caridina nilotica var. *brachydactyla* Blanco, 1935, p. 33.
Caridina nilotica gracilipes Yu, 1936, p. 88.
Caridina brachydactyla Johnson, 1960a, p. 266.
Caridina nilotica var. *brachydactyla* Johnson, 1961, p. 123.

Material examined.—British Museum:—Malaya, Penang Botanical Gardens, 19. 11.1.12–21, Indian Museum, coll. N. Annandale, February 1916, 1 ovigerous female of 26.8 mm. and 11 non-ovigerous specimens of 14.0 to 25.0 mm., cotypes of *Caridina brachydactyla peninsularis* Kemp; Singapore, Tanglin, freshwater, Bedford-Lanchester collection, 9 ovigerous females 20.8 to 27.8 mm. and 5 non-ovigerous specimens of 17.8 to 23.8 mm; Sumatra, Belawan-Deli, Medan, 22.9.99., coll. Professor Harm, 1 ovigerous female of 26.0 mm., and 7 non-ovigerous specimens of 14.0 to 21.9 mm. Leiden Museum:—Java, Rawa Mudjur Kroja, S. Central Java, August 1956, don.

A. A. Racek, 3 ovigerous females of 26.2 to 28.5 mm., and 1 non-ovigerous female of 25.0 mm.; Celebes, river nr. Palopo, Luwu, coll. M. Weber, from coll. of J. G. De Man, identified by him as *C. wyckii,* 3 ovigerous females of 26.7 to 31.5 mm.; Flores, Reo, M. Weber, originally identified by De Man as *C. wyckii,* later labelled *C. nilotica,* 6 specimens of 21.5 to 28.0 mm., the largest an ovigerous female; Flores, Mbawa, M. Weber, from coll. J. G. De Man, 26 April 1930, syntypes of *Caridina nilotica brachydactyla* De Man, 3 ovigerous females, 1 damaged, the others of 27.3 and 27.8 mm.; New Guinea, in beck at Etna Bay, 28.11.1939, New Guinea Expedition K.N.A.G. 1939, 1 male of 24.8 mm.; Timor, Lake Nefko, Dr. H. Ten Kate, 1891, 1 ovigerous female of 27.0 mm., identified by De Man as *C. wyckii* var.; New Hebrides, Anelgaupat, Aneityum islands, coll. Marshall Laird, 2.8.52., 1 juvenile of 11.5 mm.; Queensland, river near Townsville, coll. Marshall Laird, 18.6.1957, 1 specimen of 25.5 mm.; Fiji, Suva point nr. Suva, Viti Levu, coll. Marshall Laird, 12.6.1952, 1 ovigerous female of 24.2 mm.; Fiji, pool in soapstone near a stream near Naimasimasi town, Viti Levu, coll. Marshall Laird, 29.11.1953, 1 ovigerous female of 25.4 mm. Amsterdam Museum:—In the period at my disposal I was unable to examine all the *Caridina* material in this museum. Material identified by De Man as *C. nilotica* var. *gracilipes* and contained in the collections of this museum proved to belong to the present species; other material seen comprised 2 ovigerous females of 30.5 and 31.0 mm. from Kala Sliling Tajae, Bagelen, E. Java, 1911, coll. E. Jacobsen. University of Singapore:—Numerous specimens from slow streams in Singapore and South Johore including a tidal but non-saline stretch of the Sungei Seletar at Nee Soon, Singapore.

General notes.—There is still considerable confusion over the correct classification of the members of the *C. nilotica* complex. The most usual solution adopted in recent years has been to treat the complex as if it were a single, highly variable, species and recognize within it a considerable number of often inadequately defined forms. This is the solution adopted by Bouvier (1925) in his monograph. It is unsatisfactory since most workers feel that there are probably several species within the complex. It is also inconvenient in leading to a clumsy and unstable nomenclature. Unfortunately a satisfactory system of classification is only likely to be devised after a thorough study not only of museum collections but also of extensive field collections made throughout the range of the species. So far no qualified person has had both the time and the means to attempt such a task.

Nonetheless I think that some tentative attempts can be made to separate this complex into species. Typical *Caridina nilotica* (P. Roux) is essentially African. Bouvier has assigned to it specimens from Tonkin; but this record requires confirmation. *C. nilotica* subsp. *macrophora* Kemp appears at first sight to belong to *C. nilotica* proper, but, until the specimens are re-examined, it is impossible to be sure that they do not rather accord with De Man's var. *bengalensis.* The latter is probably related to *C. simoni* rather than to *C. nilotica* proper; but until the specimens can be re-examined its true systematic position must remain in doubt.

Whatever the nature of these North Indian and Indo-Chinese specimens it is clear, both from the literature and from specimens, that true *C. nilotica* and its closely allied varieties does not occur in Ceylon, in the Indo-Australian area or in Oceania. In this area there are at least two species which have formerly been included in *C. nilotica.* These are the present species and *C. wycki* S. I. Hickson.

The central form of the present species is that described by De Man as the variety *brachydactyla* of *C. nilotica*. This was later recognized as a separate species by Bouvier (1913a) and by Kemp (1918b). Bouvier (1925) later changed his opinion on the basis of supposed inter-gradation with *C. nilotica natalensis*. In my opinion there is no clear evidence for such inter-gradation. The claim rests partly on the acceptance of a figure of De Man's which Bouvier himself states does not agree with any other known specimen of *C. natalensis*. It also rests partly on the inclusion within the variety *brachydactyla* of a number of populations from the Western Indian Ocean. In the British Museum there is a specimen from Madagascar which Bouvier has identified as belonging to *C. brachydactyla*. I am very doubtful about this identification. The rostrum of this specimen differs strikingly from any of the rostral forms found in authentic specimens of *C. brachydactyla,* being much longer and with a very long unarmed distal portion of the dorsal margin. The last spine on the posterior border of the dactylus of the 3rd leg of this specimen can be said to be somewhat predominant; but it is much less so than is usual in *C. brachydactyla*.

On the basis of body form, general rostral type, and armature of the dactyli of the 3rd legs I consider that the following forms are specifically, though not necessarily sub-specifically, identical with *C. brachydactyla* De Man: *C. simoni* Bouvier from Ceylon; *C. aruensis* J. Roux from the Aru islands and also North Australia; and *C. nilotica meridionalis* J. Roux from New Caledonia. Since the name *C. simoni* is the oldest available name for this species it should be adopted for it.

The types of De Man's variety *gracilipes* were correctly referred by him to *C. wycki,* but most other specimens assigned to this variety either belong to *C. nilotica* or *C. simoni*. All specimens of this variety from localities outside Celebes but from the Indo-Australian area refer to specimens of *C. simoni* in which the dactyli are longer and more slender than is normal in that species. African records refer to similar deviations from the normal characters of *C. nilotica*.

De Man's specimens from Palopo in Celebes and from Timor, which he referred to *C. wycki,* likewise belong to *C. simoni*.

C. simoni is a rather stout species which is distinctly more heavily built than specimens of true *C. nilotica* which I have seen, though the distinction is both difficult to describe and to figure. It can most easily be distinguished from *C. nilotica* by the form and armature of the dactyli of the 3rd and 5th legs. The shortness of these dactyli is very distinctive when fully developed; but, as pointed out above, some races of *C. simoni* have more elongate dactyli which may be as long as those of typical *C. nilotica*. The detailed armature of the 3rd legs is by far the most reliable character for separating the two species. In *C. nilotica,* as also in *C. wycki,* the spines on these dactyli increase slightly but regularly in size from base to apex. By contrast, in *C. simoni* the most distal spine is very much larger than any of the others.

Within any given small area the characteristics of the local population of *C. simoni* appear to be very uniform. On this basis I think that Kemp's subspecies *peninsularis* can be recognized as valid, under the name *C. simoni peninsularis*. This subspecies is distinguishable by the rostral form and armature (Figure 5). Particularly characteristic is the fact that the dorsal margin of the rostrum is armed along its entire length. This form is found throughout the Malaya Peninsula, at least from Penang southwards, and also from Singapore. It is the only form occuring in this area. Very occasionally an aberrant individual is encountered in which a very small stretch of the dorsal margin is unarmed; this aberration is confined to a few individuals in any population.

I think it is probable that *C. simoni simoni* from Ceylon, *C. simoni brachydactyla* from Flores, *C. simoni aruensis* from the Aru Islands and *C. simoni meridionalis* from New Caledonia represent further valid local subspecies. Unfortunately our knowledge of geographic variation in this group is still inadequate for it to be possible to define the full geographical distribution of these and other possible races.

Distributional notes.—As defined above *C. simoni* is a common and widely spread in the Indo-West Pacific region. It is known from: Ceylon; Malaya; Singapore; Sumatra; Java; Celebes; the Lesser Sunda Islands; the Philippines; the Aru islands; New Guinea; Queensland; the New Hebrides; the Fiji islands; New Caledonia; and the Mariannas. It appears to be essentially an inhabitant of slow-flowing streams and rivers, but occasionally it enters low-salinity tidal waters.

Colouration.—Observations in the field suggest that colouration in life may represent a further distinction between this species and *C. nilotica.* Barnard (1950, p. 659) describes the colouration of C. nilotica from southern Africa as being, 'Semi-transparent with faint pinkish or orange-brown speckling, eyes black'. My memories of specimens taken in Uganda agree with this description. Specimens of *C. simoni peninsularis* from South Malaya can only normally be described in these terms when young. Adults vary in colour from a speckled sand-colouration to almost black in rare individuals. A pale-grey sandy colour is the most usual. There is invariable a pronounced mid-dorsal longitudinal stripe which is almost colourless, giving a very striking colour pattern.

Caridina wycki (S. I. Hickson, 1888).

=*Atya wycki* S. I. Hickson, 1888, p. 957.
Caridina wycki Thallwitz, 1891, p. 27.
Caridina wycki var. *gracilipes* De Man, 1892, p. 387.
Caridina nilotica var. *minahassae* De Man, 1902, p. 895.
Caridina wycki var. *gracilipes* Schenkel, 1902, p. 895.
Caridina wycki J. Roux, 1904, p. 554.
Caridina wycki var. *gracilipes* J. Roux, 1904, p. 554.
Caridina nilotica var. *minahassae* J. Roux, 1904, p. 555.
Caridina wycki partim Bouvier, 1905, p. 79.
Caridina nilotica var. *wyckii* De Man, 1908, p. 269.
Caridina nilotica var. *minahassae* De Man, 1908, p. 271.
Caridina nilotica var. *gracilipes* De Man, 1908, p. 270.
Caridina nilotica var. *gracilipes* Rathbun, 1910, p. 316.
Caridina nilotica var. *longirostris* partim Bouvier, 1925, p. 149.
Caridina nilotica var. *wycki* Bouvier, 1925, p. 151.
Caridina nilotica var. *Minahassae* Bouvier, 1925, p. 152.
Caridina nilotica var. *gracilipes* partim Bouvier, 1925, p. 152.
Caridina lingkonae E. Woltereck, 1937, p. 218.
Caridina towutensis E. Woltereck, 1937, p. 220.
Caridina spinata E. Woltereck, 1937, p. 221.
Caridina loehae E. Woltereck, 1937, p. 222.
Caridina mesapi E. Woltereck, 1937, p. 223.
Caridina lanceolata E. Woltereck, 1937, p. 224.
Caridina tenuirostris E. Woltereck, 1937, p. 224.

Material examined.—British Museum:—Celebes, 1955.4.22.55–62, presented Univ. Coll. Dundee, labelled *Atya wycki,* several hundred specimens, mostly fragmented and damaged, of which a small sample ranging in size from 10.0 to 18.5 mm. was examined critically; Lake Tondano, Celebes, 88.11, 2,000 ft., cotypes of *Atya wycki,* several hundred damaged and fragmented specimens of which a sample of 5 specimens of size 16.3 to 17.5 mm. were examined critically. Cambridge Museum:—Lake Tondano, N. Celebes, cotypes of *Atya wycki,* several hundred specimens which are mostly damaged, of which a sample of 10, carapace lengths 3.8 to 4.8 mm., were examined. Leiden Museum:—Lake Tondano, N. Celebes, 2,000 ft., cotypes of *Atya wycki,* 33 of 9.9 to 20 mm. including an ovigerous female of 17.0 mm.; Netherlands East Indies, Zool. Lab. Utrecht, 18 poorly preserved specimens of 10.5 to 19.0 mm., the largest an ovigerous female; Minahassa, Celebes, coll. Kukenthal 1893/94, cotypes of *Caridina nilotica* var. *minahassae* De Man, 2 specimens of 15.0 to 16.0 mm.; Maros river, Celebes, cotypes and others of original series of *Caridina wycki* var. *gracilipes* De Man, coll. Max Weber, 2 ovigerous females of 25.3 and 29.0 mm., and third smaller damaged female, 4 non-ovigerous specimens of 22.0 to 26.0 mm.

General notes.—In my opinion *Caridina wycki* is a valid species distinct from both *C. nilotica* and *C. brachydactyla.* De Man's type material of *C. wycki* var. *gracilipes* differs from Hickson's form only in minor details of limb proportions. On the other hand most material that has been referred to this variety by subsequent authors belongs either to *C. brachydactyla* or *C. nilotica. C. nilotica* var. *minahassae* De Man is, in my opinion merely a variety of *C. wycki.* On the basis of her descriptions I also consider that the species created by E. Woltereck for forms from Celebean lakes are merely variants of *C. wyci.* Similarly the Celebean specimens which Bouvier referred to *C. nilotica* var. *longirostris* belong here. Since there is no precise and correct geographical location for the original specimens of this variety it is impossible to identify the variety as a whole with any certainty and the name becomes a *nomen dubium.*

C. wycki differs from *C. brachydactyla* in its small size and graceful, fragile build. The chela of the first legs is much stouter and the carpus is much shorter than is usual in *C. brachydactyla.* The spines on the dactyli of the third legs increase gradually in size distally, the last not being exceptionally large.

Distributional notes.—*C. wycki* is endemic to Celebes, where it appears to be an abundant lacustrine species.

Caridina weberi weberi De Man, 1892.

=*Caridina Weberi* De Man, 1892a, p. 371.
Caridina parvirostris De Man, 1892a, p. 375.
Caridina Weberi De Man, 1892b, p. 261.
Caridina parvirostris Ortmann, 1895, p. 404.
Caridina Weberi var. *celebensis* Schenkel, 1902, p. 499.
Caridina Weberi var. *celebensis* J. Roux, 1904, p. 553.
Caridina Weberi Bouvier, 1905, p. 75.
Caridina parvirostris Bouvier, 1905, p. 76.
Caridina Weberi Bouvier, 1912, p. 919.
Caridina parvirostris Bouvier, 1912, p. 919.
Caridina Weberi Bouvier, 1913a, p. 465.
Caridina parvirostris Bouvier, 1913a, p. 465.
Caridina Weberi var. *typica* Bouvier, 1925, p. 243.
Caridina Weberi var. *parvirostris* Bouvier, 1925, p. 244.
Caridina Weberi var. *celebensis* Bouvier, 1925, p. 246.

Material examined.—29 specimens in the Leiden Museum from Bexoeki; Palopo, Celebes; Kotting, Flores; Betilonga, Guadalcanal, Solomon Islands, coll. Marshall Laird; Viti Levu, Fiji, coll. Marshall Laird; and, possibly of this form, from Anelgauhat, Aneityum, New Hebrides, coll. Marshall Laird.

General and Distributional notes.—On the basis of these specimens and the published descriptions it appears to me that the typical sub-species must include the varieties *parvirostris* and *celebensis*. I similarly cannot differentiate the specimens from the Solomon Islands and from Fiji from the typical sub-species. In the specimens from Aneityum the 1st leg is more slender than in typical individuals and there are fewer post-orbital teeth. It is possible that there is a distinct New Hebrides race; but these specimens are juveniles so there can be no certainty of this.

I have not been able to examine specimens from the New Guinea region and thus cannot assess the validity of the varieties *papuana* Nobili and *keiensis* J. Roux. Judging by the summaries of characters given by Bouvier these two varieties are so closely allied that they should most probably be considered as synonymous. Their relationship to the typical form is more doubtful. Bouvier's account implies that they differ noticeably from the typical form. On the other hand it seems unlikely that a distinct geographic subspecies should occur in New Guinea and the Kei islands when the typical subspecies occurs on either side of this region. The status of these forms must thus remain doubtful until more material can be examined.

Caridina weberi sumatrensis De Man, 1892.

=*Caridina Weberi* var. *sumatrensis* De Man, 1892a, p. 375.

Caridina Weberi var. *sumatrensis* Nobili, 1900, p. 476.

Caridina Weberi var. *sumatrensis* Bouvier, 1925, p. 248.

Material examined.—17 specimens in the collections of the British Museum and several specimens in the collections of the University of Singapore.

Distributional notes.—Specimens which I have examined come from Malaya; Belawan Deli in Sumatra; and Hong Kong (collected by R. Barney and presented by S. Kemp). The established range of this subspecies seems to be from Sumatra and Malaya through to Hong Kong. Specimens reported from the Comoro Islands, the Persian Gulf, Arabia, and India may represent a further subspecies or several subspecies.

Caridina pristis J. Roux, 1931.

=*Caridina pristis* J. Roux, 1931, p. 63.

Material examined.—23 specimens in the British Museum from the following localities in Ceylon: Giant's Tank, coll. D. R. R. Burt; Kelani River, Colombo, coll. D. R. R. Burt; Kekiwara, coll. D. R. R. Burt; Peradeniya, coll. R. Gurney.

General and Distributional notes.—This species is very close to *C. weberi sumatrensis* but in my opinion it diverges sufficiently from all known forms of *C. weberi* to merit specific status. It is confined to Ceylon where it replaces *C. weberi.*

Caridina typus H. M. Edwards, 1837.

see Bouvier, 1925, p. 249; Johnson, 1960a, p. 179.

Material examined.—Nearly 300 specimens in the collections of the British Museum, the Cambridge Museum, the Leiden Museum and the University of Singapore.

General notes.—Bouvier (1925) recognizes three varieties on the basis of rostral variations. I find that three are specimens which do not agree with any of these varieties. Whilst recognizing that there is evidence for geographical variation I consider that much more extensive collections must be made before subspecies can be recognized in this species.

Distributional notes.—I am able to add the following localities to those previously reported for this species: near Durban, swift stream ½ ml. from sea, coll. P. A. Buxton, British Museum; Bos Lussen, 20–30 km. N.E. of Amboahobe, S. Africa, 8.9.38, Leiden Museum; Rollingstone, N. Queensland, 17.6.54., coll. Marshall Laird, Leiden Museum; Anelgauhat, Aneityum, New Hebrides, 27.2.53, coll. Marshall Laird, Leiden Museum; close to edge of lake on Gana, New Hebrides, 6.6.57, coll. J. R. Baker, British Museum; Art Islands, Belew Isles, about 50 mls. north of New Caledonia, 2.12.52, Marshall Laird, Leiden Museum; Koumac, North New Caledonia, 4.12.52., in small river, coll. Marshall Laird, Leiden Museum; Fiji Islands, coll. Professor Gilsen, British Museum; Maloloei, Upolu, Samoa, 4.5.24., stream in cave, coll. Buxton, pres. Gurney, British Museum; Lake Candidius, Central Formosa, British Museum; fast streams, Langkawi Island, Malaya, coll. D. S. Johnson, University of Singapore.

C. typus is widely distributed in the Indo-West Pacific; but it has a distinctly insular distribution. In Africa and Asia it is only found in a few fringing localities, never far from the sea, and never in major river systems. I have given a map of this distribution (Johnson, 1960a). In habits it is essentially a torrent stream species, though it has been recorded from lake margins. Both in appearance and habits it closely resembles part-grown individuals of *Atya spinipes.* So far as I can tell it seldom if ever occurs along with that species and competition with it may be one factor in limiting the distribution of *Caridina typus.* Certainly it is difficult otherwise to explain the abundance of *Caridina typus* on Langkawi Island together with its apparent absence from apparently suitable streams, occupied by *Atya spinipes* elsewhere in Malaya.

Holthuis (1956) has given an enumeration of troglobic Atyidae, including accidental occurences of essentially non-troglobic species. *Caridina typus* must now be added to this list on the basis of the specimens listed from Samoa.

TABLE 1

The identity of the non-marine Caridea of the 'Skeat' Expedition reported on by Lanchester (1901)

Lanchester's Name.	Correct Name.
Palaemon carcinus	= *Macrobrachium rosenbergi.*
Palaemon carcinus var. *lamarrei*	= *Macrobrachium rosenbergi.*
Palaemon equidens	= *Macrobrachium neglectum.*
Palaemon lampropus	= *Macrobrachium latidactylus.*
Palaemon nipponensis	= *Macrobrachium sintangense.*
Palaemon paucidens	= *Macrobrachium lanchesteri.*
Palaemon pilimanus from Aring	= *Macrobrachium malayanum.* + *Macrobrachium pilimanus.*
Palaemon pilimanus from Belimbing	= *Macrobrachium malayanum.*
Palaemon sundaicus	=?*Macrobrachium asperulum.*
Caridina gracillima	Correct as subspecies of *Caridina gracilirostris.*
Caridina multidentata	Probably correct.
Caridina wyckii	Unidentifiable, probably a form of *Caridina gracilirostris.*
Atya armata	= *Atya spinipes.*

THE IDENTITY OF LANCHESTER'S (1901) SPECIES

The records of Natantia given by Lanchester in 1901 constitute the longest list of freshwater forms from Malaya given before 1960. It is thus of some importance to tabulate the identities of these specimens. These re-identifications are based on re-examination of Lanchester's material. In a few instances this material was so damaged that identification was impossible; but for the most part it has been possible to reach reasonably certain conclusions. These are summarized in Table 1.

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Breeding experiments and Pelage differences between two subspecies of *Rattus rattus (diardii* and *jalorensis)* in Malaya[1]

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INTRODUCTION

FOR A COMPREHENSIVE interpretation of the systematics of two closely related species or subspecies, it is necessary to study not only morphological differences but also genetical, ecological and physiological differences. The ecological ranges and geographical distribution of the two subspecies considered here, *Rattus rattus diardii* (Jentink), and *Rattus rattus jalorensis* (Bonhote), have been dealt with in a previous paper (Dhaliwal, 1961). Genetical studies are important as the species concept of present day systematics is primarily a genetical concept. Before the systematic status of any two closely related species or subspecies can be throughly understood, it is necessary to determine the extent to which they can hybridize. Particularly, it is convenient to compare the colour of hybrids with that of parental types and to work out the genetical basis of the colour differences. The present paper reports attempts at hybridization between *diardii* and *jalorensis* in the laboratory and a study of variation in dorsal and ventral pelage colour within and between the two subspecies.

MATERIALS AND METHODS

All the rats used in the present study were wild-caught specimens. Those used in the breeding experiments were trapped in Singapore, South Johore and the vicinity of Kuala Lumpur, Central Malaya (20 specimens obtained from the Institute for Medical Research, Kuala Lumpur).

For a study of variation in pelage colour, flat skin preparations were made according to the method of Elton (1938). Altogether 96 flat skins of *diardii* and 44 flat skins of *jalorensis* rats were examined. Of these, 34 *diardii* and 30 *jalorensis* trapped around Kuala Lumpur were obtained from the Institute for Medical Research. The remainder came from urban and rural areas of Singapore.

The flat skins were compared with the Maerz and Paul 'Dictionary of Color' (1930) in a dark room where the only source of light was a fluorescent lamp (Osram Daylight, 40W, 220V, type 62611). The lamp was placed directly over the working area, 195 cm. away from the colour plates. All colour comparisons were made with the observer's forehead in contact with a tightly stretched thread, insuring a constant distance of 60 cm. between the observer's eyes and the plates. Skins were always placed on the right side of the colour plates at the same fixed position. A square piece of neutral grey paper (20 cm. square) was used for covering the skin leaving only a rectangular hole (1.5 cm. x 1.2 cm.) through which the colour could be seen. A similar piece of paper was used for covering up the colour plates so that only one colour rectangle (1.5 x 1.2

[1]The present report continues from Dhaliwal (1962), in reporting on the relationships between the common Malayan House Rat (*Rattus r. diardii*) and the common Malayan Field Rat (*R. r. jalorensis*).

cm.) was in view at a time. The skins were mixed and coded before the comparison with the colour plates. Comparisons were made on the dorsal and ventral surfaces of the skins equidistant from tip of head and base of tail in every case. The surface of each skin was brushed with a nail brush so that a standard texture of the skins could be obtained. The results were tabulated and analysed statistically.

Samples of hair were collected either from freshly chloroformed rats or from flat skin preparations. The hair samples were collected from 3 regions: mid-dorsal, mid-ventral and behind the ears. Whole hairs were plucked and placed in 50% glycerine in distilled water for several days. A modification of Russell's (1946) method was used for making permanent mounts of the hair samples. This method removed all the air out of their cells and left the melanin pigment granules and the medullary cells clearly visible. Projection drawings of whole hairs were made by using a photographic enlarger and measurements of hair lengths were made from these drawings.

BREEDING EXPERIMENTS

Breeding experiments were set up between *diardii* and *jalorensis* rats in order to determine whether they would hybridize in the laboratory. Hybridization between the two rats would help in the establishment of their systematic status although hybridization in the laboratory is no criterion for concluding that the two subspecies hybridize under natural conditions. Control crosses within *diardii* and *jalorensis* were also set up. The breeding experiments were carried out over a period of one year.

TABLE 1

Numbers and percentages of fertile crosses. (In brackets are given the number of litters where more than two litters were produced)

Type of cross	No. of crosses	No. of crosses with one litter only	No. of crosses with two or more litters	Total No. of fertile crosses	Percentage age of fertile crosses
diardii x *diardii*	14	4	4	8	57
jalorensis x *jalorensis* ..	12	3	1(3)+1(4)	5	42
Totals intrasubspecific ..	26	7	6	13	50
diardii x *jalorensis*	5	1	1	2	40
jalorensis x *diardii*	6	..	1(4)	1	17
Totals intersubspecific ..	11	1	2	3	27

The type of crosses and the results are summarised in Table 1. It can be seen that crosses within each subspecies have a higher percentage of fertile crosses than crosses between the two subspecies. However, this difference is not statistically significant.

A total number of twenty-five hybrids were produced from three out of the eleven hybrid crosses set up. It was observed that all the hybrid rats had dark ventral body colours. As far as the colouration of the ventral fur is concerned they were entirely indistinguishable from the *diardii* adults. It was particularly noted that in one case where the *diardii* mother had a light coloured ventral body surface, the hybrid young had ventral surfaces even darker than the *diardii* mother.

In the crosses between the two subspecies very few rats would settle down with their partner immediately. Most would settle down after some fighting, whereas a few rats would not settle at all and would fight to the extent of killing the weaker partner. No such outstanding hostility was observed in the crosses within each subspecies even where rats had been freshly brought from the field. This marked hostility between the two subspecies indicated that they do not hybridize in nature.

F_1 crosses and backcrosses were set up between the hybrids and the *diardii* and *jalorensis* parents. However, no offspring were produced during three months for which the crosses had been set up. The age of these rats was about four months when the crosses were set up.

PELAGE COLOUR

Bonhote (1903) has described the colour differences between *diardii* and *jalorensis*. The most striking difference is in the ventral fur colour, which is pure white in *jalorensis* and dull grey in *diardii*. Dorsally, *diardii* is rather paler than *jalorensis* and is more uniform in colouration throughout, being hardly, if at all darker along the centre of the back (Bonhote, 1903).

While the general differences described above are clear enough to any observer, observations on colour are usually highly subjective and not susceptible to the sort of exact analysis which was desired in this study. Accordingly, every attempt was made to reduce the colour analyses to strictly objective terms.

Series of flat skins of *diardii* and *jalorensis* from different localities were first compared to note any gross differences. The total collection of skins were then coded and compared with the Maerz and Paul 'Dictionary of Color' as described earlier. The various colour squares in the 'Dictionary of Color' were assigned arbitrary numbers so that a statistical analysis could be carried out. The results were analysed in various ways and the most significant findings are mentioned below.

It was found that *jalorensis* rats trapped in Singapore and the southern tip of Malaya were much darker dorsally than those trapped around Kuala Lumpur in Central Malaya. The dorsal stripe is also more prominent in the Singapore and South Malaya *jalorensis* rats than those from Central Malaya. In the case of *diardii,* there is no constant difference in dorsal colour between specimens from Singapore and Central Malaya. There is also no consistent difference in dorsal colour between *diardii* and *jalorensis* from Central Malaya, although generally it can be said that the dorsal stripe is more prominent in *jalorensis* than in *diardii*.

TABLE 2

Number of skins in each colour group with regard to amount of grey in dorsal body colour of *R. r. diardii* and *R. r.* jalorensis. "Less grey" = reflection factors of 20.4% and "More grey" = reflection factor of 10.0% (Maerz and Paul)

Subspecies	Less Grey	More Grey	Total
Singapore *diardii*	28	34	62
Kuala Lumpur *diardii*	22	12	34
Singapore *jalorensis*	0	9	9
Kuala Lumpur *jalorensis*	26	9	35

Comparison with the Maerz and Paul 'Dictionary of Color' showed that with respect to the dorsal colour the skins of *diardii* and *jalorensis* rats compared with only two plates (7 & 8) in the Red-to-Orange range which differed in the amount of grey—one group having a reflection factor of 20.4% and the other group (with more grey) having a reflection factor of 10.0%. Table 2 gives the number of skins of *diardii* and *jalorensis* which fell in each group with respect to the amount of grey in their dorsal body colour. As noted above there is no significant difference between Singapore *diardii* and Kuala Lumpur *diardii* ($\chi^2 = 3.36$, $P = 0.07$). The difference between Singapore *jalorensis* and Kuala Lumpur *jalorensis* is highly significant ($\chi^2 = 16.34$, $P = 0.000,017$) —Singapore *jalorensis* being more grey than Kuala Lumpur *jalorensis*. However, there is no significant difference between Kuala Lumpur *diardii* and Kuala Lumpur *jalorensis* ($\chi^2 = 0.75$, $0.5 > P > 0.3$).

TABLE 3

Means and standard errors of means with respect to amount of orange in dorsal body colour of *R. r. diardii* and *R. r. jalorensis*. *Colour rank "7" in Maerz and Paul used as value "7" here, etc.

Subspecies	M. *±S.E.
Singapore *diardii*	9.69 ± 0.13
Kuala Lumpur *diardii*	9.68 ± 0.15
Singapore and Kuala Lumpur *diardii*	9.69 ± 0.10
Singapore *jalorensis*	7.89 ± 0.20
Kuala Lumpur *jalorensis*	9.94 ± 0.17

Further analysis of the dorsal colour showed random distribution for the factor "red", but a normal distribution with respect to the factor "orange." The means and standard errors for this factor have been worked out and expressed in Table 3. Again there is a highly significant difference only between Singapore *jalorensis* and Kuala Lumpur *jalorensis* (P is very low).

The most outstanding difference between the two subspecies is in the ventral body colour. The *jalorensis* examined all had a white belly colour except for a few which were very slightly grey. None of the *diardii* examined had the white ventral colour of *jalorensis*. There is practically no variation within *jalorensis* in ventral colour.

The ventral colour of *diardii* is very variable but it is never pure white. It ranges from dilute grey to dark grey with no particular grade dominating over the others. It was noted that the range was greater (especially towards light grey) in Singapore *diardii* than in those from Central Malaya.

Rats kept in the laboratory, both *diardii* and *jalorensis,* had slightly orange-coloured underparts which probably was a nutritional effect due to the red palm oil included in their diet.

TABLE 4

Numbers of skins of *R. r. diardii* and *R. r. jalorensis* which compared with various plates of Maerz and Paul 'Dictionary of Color' in their ventral body colour. Within brackets are given the reflection factors for the various plates

	Plate 10–A1 (73.5%)	Plate 11–A1 (66.7%)	Plate 12–A1 (47.6%)	Total
Singapore *jalorensis* ..	5	4	..	9
Kuala Lumpur *jalorensis* ..	21	14	1	36

	Plate 13 (38.3%)	Plate 14 (28.0%)	Plate 15 (20.4%)	Plate 16 (10.0%)	Total
Singapore *diardii*	10	23	28	1	62
Kuala Lumpur *diardii* ..	2	22	10	..	34

The *jalorensis* skins showed only slightly variation in the amount of grey colour ventrally; all compared with the "A-1" squares of Plates 9–12 of the 'Dictionary of Color'. The "A-1" squares show increasing amounts of neutral grey from pure white in Plate 9 to dark grey in Plate 16. All the *diardii* skins compared with Plates 13 to 16, most comparing with the "A-1" squares, while a few showed slight variations within these plates toward yellow and orange. There was no overlapping between the two subspecies for this character (Table 4).

TABLE 5

Means ± S.E. of means and coefficients of variation for the amount of grey in ventral colour of *R. r. diardii*. Number of plates used as units of measurement

——	M. ± S. E.	C.V. (%)
Singapore *diardii*	14.11 ± 0.12	6.23
Kuala Lumpur *diardii*	14.24 ± 0.10	3.45

Table 5 gives the means and standard errors of means (the number of the plates being taken as the unit of measurement) for the amount of grey in ventral colour for Singapore *diardii* and Kuala Lumpur *diardii*. There is no significant difference between the two for this character. However, Singapore *diardii* are more variable than those from Kuala Lumpur.

HAIR TYPES

The types of hair found in the coats of both *diardii* and *jalorensis* fall, with one difference, into the same categories as those described by Dry (1926) for the mouse, namely:—

(*a*) Guard hairs, which are long, straight hairs and generally stand above the level of the rest of the coat.

(*b*) Spines, which are also straight, average about two-thirds the length of the guard hairs and are thicker than the guard hairs.

(*c*) Auchenes are about the same length as the spines and are variable in thickness. They are distinguishable from spines in that they have one sharp bend approximately at the middle of the hair. The diameter of the hair is constricted at this bend.

(*d*) Zigzags are short, wavy hair which form the main part of the coat. They usually have two to four sharp bends at which their diameter is also constricted.

Dry (1926) described awls which are straight hairs but are only about one-half to two-thirds the length of the guard hairs. Spines, described above, are comparable with awls but are called spines because of their great thickness and sharp, pointed tip. The general appearance of the four types of hair described above is illustrated in Figure 1.

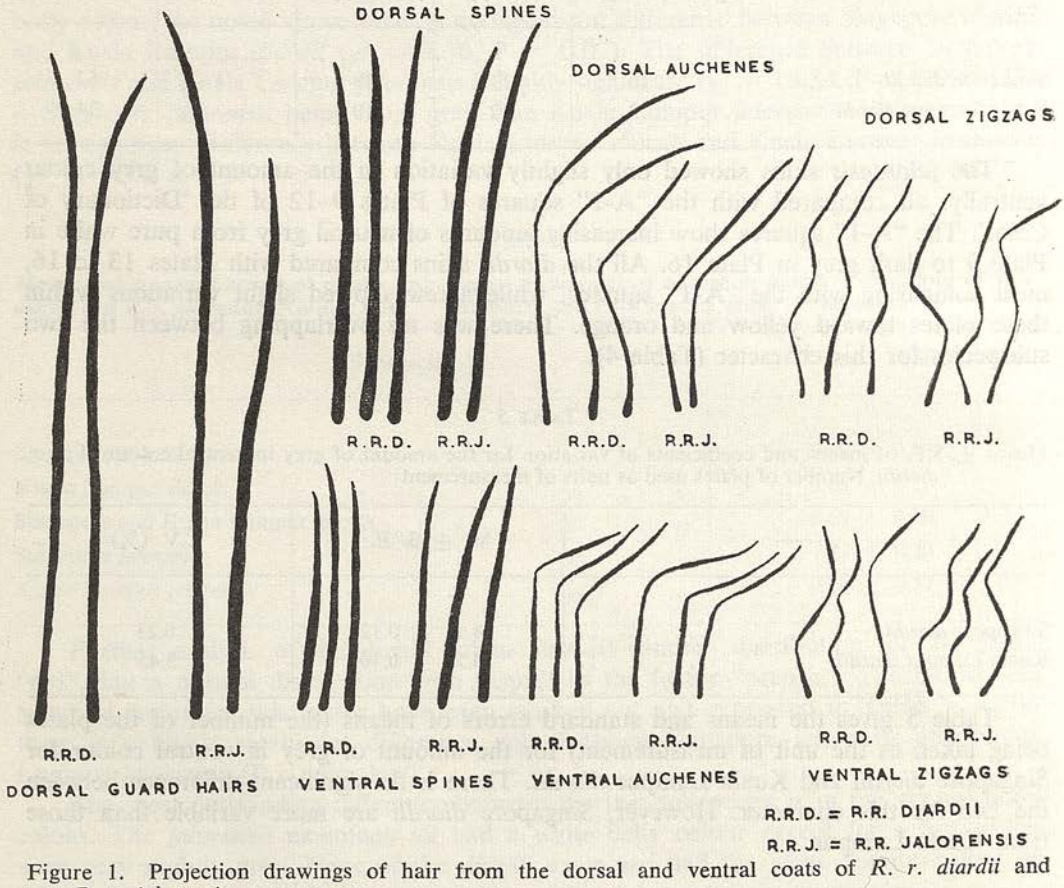

Figure 1. Projection drawings of hair from the dorsal and ventral coats of *R. r. diardii* and *R. r. jalorensis.*

Hairs counts were made on both subspecies on the dorsal and ventral surfaces. A small area (about half square cm.) was selected approximately at the middle of the dorsal and ventral surface and all the hairs in this area were plucked and placed in 50% glycerine. For counting the numbers of hairs a small sample (about 400–600 hairs) was taken out of glycerine, placed on a slide and the numbers of different types of hair were counted under a binocular microscope. The numbers were then expressed as percentages. Table 6 gives the mean percentages and the standard errors of the means (based on ten samples in each case) for the various types of hair in both *diardii* and *jalorensis*.

TABLE 6

Mean percentages ± S.E. of means for the numbers of different types of hair in a random sample from the dorsal and ventral surfaces of *R. r. diardii* and *R. r. jalorensis*

——	Guard Hairs	Spines	Auchenes	Zigzags
Rattus r. dairdii				
Dorsal surface ..	1.14 ± 0.29	4.68 ± 0.91	18.79 ± 1.64	75.31 ± 2.4
Ventral surface ..	Nil	3.73 ± 0.74	9.56 ± 1.02	86.81 ± 1.47
Rattus r. jalorensis				
Dorsal surface ..	1.01 ± 0.1	3.48 ± 0.62	13.43 ± 1.26	80.18 ± 1.02
Ventral surface ..	Nil	2.03 ± 0.11	5.71 ± 0.47	92.26 ± 0.68

There are no significant differences between *diardii* and *jalorensis* in the numbers of different types of hair on the dorsal surface. However, there are differences between the two subspecies on the ventral surface. *Diardii* rats are significantly ($0.001 > P > 0.000,1$) more spiny on the ventral surface than *jalorensis* and *diardii* have more auchenes than *jalorensis* ($0.002 > P > 0.001$). The difference between the percentage of zigzags on the ventral surface between the two subspecies is significant, *jalorensis* having more zigzags than *diardii* ($0.001 > P > 0.000,1$). The presence of greater numbers of spines and auchenes on the ventral surface in *diardii* explains the roughness of its ventral surface compared with that of *jalorensis*.

The obvious difference between the dorsal and ventral surfaces in both the subspecies is the complete absence of guard hairs on the ventral surface. In *diardii* there is no significant difference in the number of spines between the two surfaces while in *jalorensis* the dorsal surface is more spiny than the ventral surface ($0.03 > P > 0.02$). In both *diardii* and *jalorensis* there are highly significant differences in the numbers of auchenes and zigzags between the dorsal and ventral surfaces. (P is small in both cases).

HAIR LENGTHS

Twenty fully developed hairs of each type were mounted in glycerine and projection drawings made. The lengths of these hairs were measured from the drawings and are expressed in Table 7. The hairs measured were collected from the mid dorsal and mid ventral surfaces of ten different rats from each subspecies.

TABLE 7

Mean lengths in millimeters of the various types of hair (dorsal and ventral) in *diardii* and *jalorensis*, with standard errors and coefficients of variation

	Guard Hairs		Spines		Auchenes		Zigzagz	
	M. ± S.E.	C.V. (%)	M. ± S.E.	C.V. (%)	M. ± S.E.	C.V. (%)	M. ± S.E.	C.V. (%)
Rattus r. diardii								
Dorsal ..	21.71±0.56	11.52	12.03±0.50	18.75	9.28±0.25	12.12	6.97±0.19	12.48
Ventral ..	..	..	6.22±0.15	10.59	5.95±0.15	11.36	4.94±0.12	11.12
Rattus r. jalorensis								
Dorsal ..	19.27±0.63	12.58	11.45±0.29	11.33	9.48±0.43	20.46	7.84±0.20	11.47
Ventral ..	..	..	6.3±0.16	11.71	6.47±0.13	9.21	5.32±0.13	11.10

Between *diardii* and *jalorensis* there is a significant difference between the lengths of guard hairs—*diardii* having longer guard hairs than *jalorensis* ($0.01 > P > 0.002$). There is no significant difference between the two subspecies in the lengths of dorsal spines and auchenes. However, *jalorensis* have significantly longer zigzags than *diardii* ($0.002 > P > 0.001$).

Ventrally, *jalorensis* have significantly longer auchenes and zigzags than *diardii*.

MICROSCOPICAL STRUCTURE OF HAIR

Permanent mounts of hair were examined under oil immersion to see if there were any differences in the hair structure between the two subspecies, especially with regard to pigmentation of ventral hair.

The four types of hair differ in their internal structure, particularly in the number of longitudinal rows of medullary cells. Guard hairs from the dorsal surface of mice have two rows of air-cells (Dry, 1926). It was difficult to establish clearly the number of

rows of medullary cells in guard hairs in these rats because of the heavy pigmentation. Moreover, guard hairs have a thick cuticle and a thick, heavily pigmented cortex (Figure 2a). However, it appears that the guard hairs from these rats have one or two rows of medullary cells. Apart from cortical granules, the cortex of guard hairs have orange streaks which are more prominent towards the tip. These streaks must be responsible for the fulvous tips of the guard hairs, visible to the naked eye.

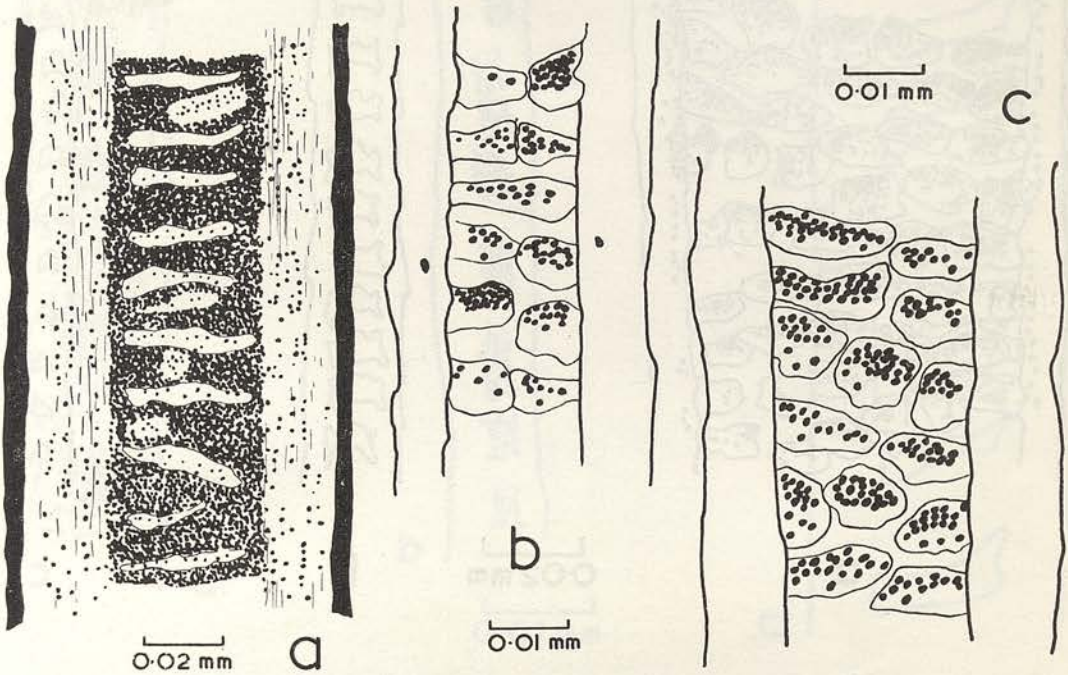

Figure 2. (*a*) H. P. camera lucida drawing of a dorsal guard hair from *R. r. diardii*. Note heavy pigmentation, thick cortex and keratin. (*b–c*) H. P. drawings of ventral spines from *R. r. diardii*. On the left (*b*) is a spine from a *diardii* with a light type of ventral colour and on the right (*c*) is a spine from a *diardii* with a dark type of ventral colour. Camera lucida drawings.

Spines are thicker than all the other types of hair, usually about one and a half times thicker than the guard hairs at their thickest parts. The number of longitudinal rows of medullary cells in a spine are not constant along the length of the spine. In the basal part and towards the tip there is only one row and at the thickest part there are six to eight rows of medullary cells (Figures 2b, 2c, 3a). Dorsal spines, when seen with the naked eye, appear to have a light base and a very dark tip. This is more prominent in *jalorensis* than in *diardii*. Microscopical examination of dorsal spines in both subspecies showed that there were very few granules close to the base and the number of granules increases towards the tip, especially the number of cortical granules.

However, at the very tip the number of granules again decreases. Ventral spines do not have dark tips and have practically no cortical granules. Dorsal spines in *jalorensis* are generally thicker than those of *diardii*.

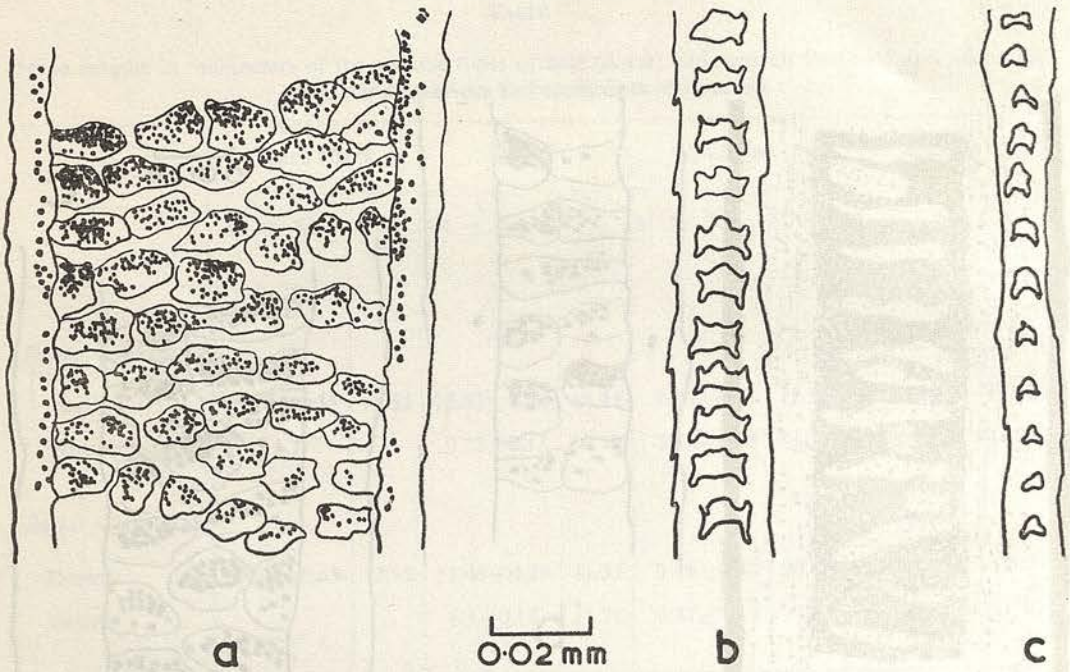

Figure 3. (*a*) H. P. drawing (camera lucida) of the basal part of a dorsal spine (*R. r. jalorensis*). (*b–c*) H. P. camera lucida drawings of a ventral zigzag from *R. r. jalorensis*. On the left (*b*) is a drawing from close to the tip and on the right (*c*) at a constriction close to the base. Note absence of pigment granules.

Auchenes are variable in thickness, varying from one row to four rows of medullary cells. They are distinguished from other types of hair in that they have one sharp bend at about the middle of the hair. The diameter of the hair is constricted at the bend. Above the constriction the diameter of auchenes is greater than that below the constriction (Figure 4). The air spaces at the constriction are reduced but never completely obliterated. Most of the ventral auchenes have only one row of medullary cells, although a few have two or three rows.

Zigzags have two to four sharp bends along the length of the hair and all zigzags have only one longitudinal row of medullary cells (Figures 3b, 3c, 5). At the bends the

diameter of all zigzags is constricted and sometimes the air space is completely obliterated. In dorsal zigzags, again, there are more pigment granules towards the tip, particularly in the cortical region.

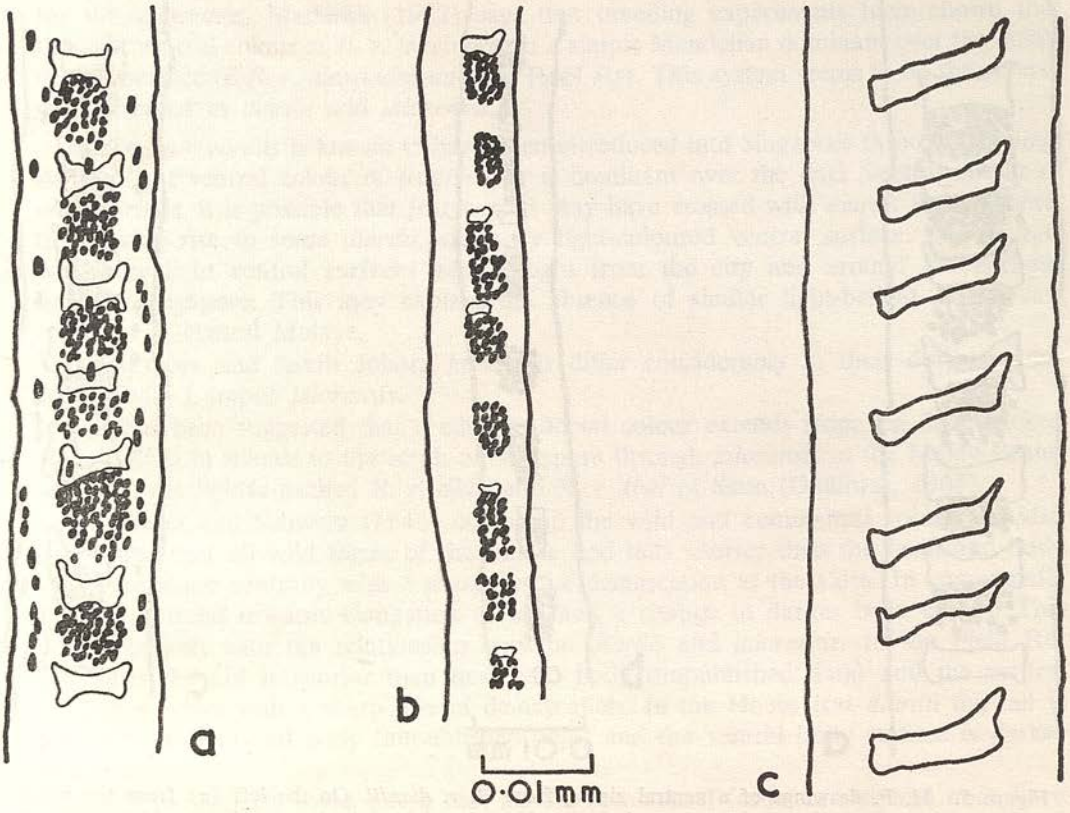

Figure 4. H. P. camera lucida drawings of a ventral auchene from *R. r. diardii* (dark ventral surface). On the left (*a*) is a drawing from the basal part, in the middle (*b*) at the constriction and on the right (*c*) above the constriction. Note absence of pigment granules above the constriction.

Since the main difference between the two subspecies is in the ventral body colour, samples of ventral hair from both the subspecies were thoroughly studied. The most outstanding difference between the ventral hair of *diardii* and that of *jalorensis* is the complete absence of pigment granules in the auchenes and zigzags of *jalorensis* (Figures 3b, 3c, 5). The zigzags in *diardii* have both cortical and medullary pigment granules along the whole length of the hair. In the ventral auchenes of *diardii* the number of cortical and medullary pigment granules is reduced at the constriction and they are completely absent above the constriction. The complete absence of pigment granules in auchenes and zigzags from the ventral surface of *jalorensis* and the presence of pigmentation in the same type of hair in *diardii* is an absolute difference between the two subspecies. Even auchenes and zigzags from *diardii* rats with very light ventral

surfaces had pigment granules. The extent of pigmentation in the ventral hair of *diardii* in different individuals is highly variable, which accounts for the large range of variation observed previously.

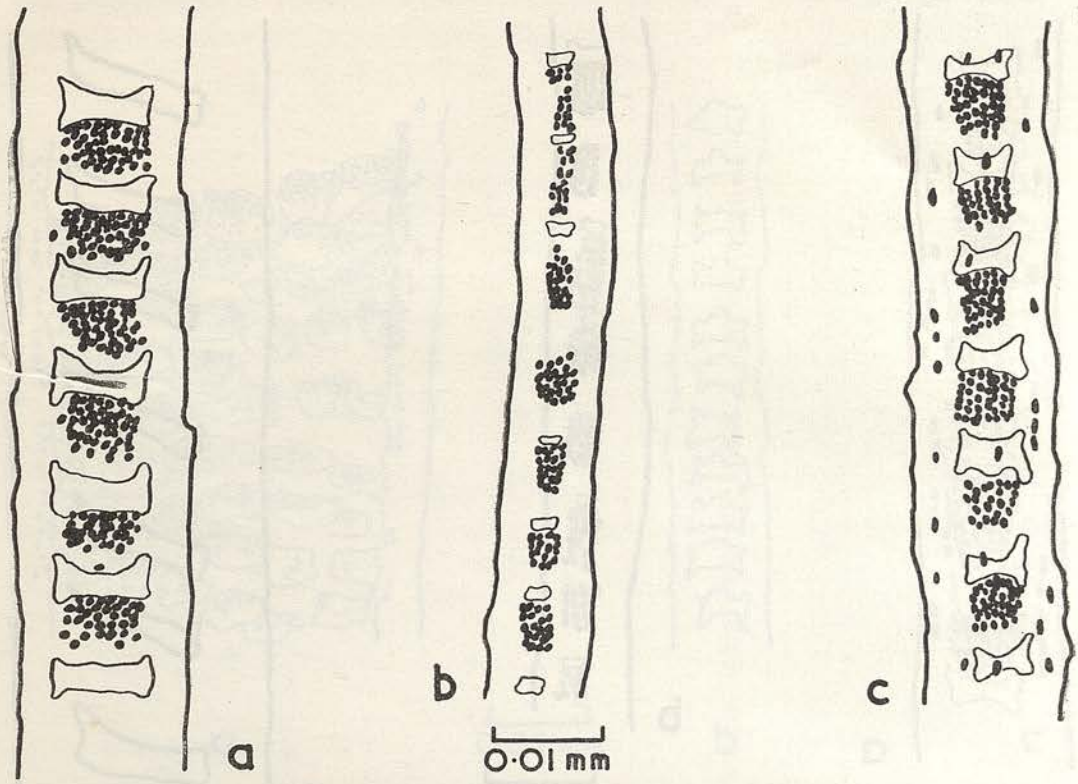

Figure 5. H. P. drawings of a ventral zigzag from *R. r. diardii*. On the left (*a*) from the basal part, in the middle (*b*) at a constriction and on the right (*c*) close to the tip. Note pigment granules present along whole length of zigzag. Camera lucida drawings.

Spines from the ventral surfaces of both *diardii* and *jalorensis* have pigment granules, but there are fewer in *jalorensis* than in *diardii*. It is notable here that in the case of *jalorensis* the pigment granules are only present close to the base of the spine. The colour of the cortical and medullary pigment granules is dark brown in both subspecies.

DISCUSSION

It has been shown that hybridization between the two subspecies can take place, at least in the laboratory. The number of crosses and the number of litters produced were too small to show whether there are significant statistical differences in the results between the different types of crosses. However the results suggest reduced fertility in the intersubspecific crosses. The hybrids failed to produce offspring in F_1 crosses and in backcrosses over a period of three months, although the age of the hybrids was four months when the crosses were set up.

The obvious difference between the two subspecies is in ventral colour which is almost always pure white in *jalorensis* and varies from light grey to dark grey in *diardii*.

All the hybrids produced in the laboratory had dark ventral surfaces which were indistinguishable from those of *diardii*. This shows that the dark ventral colour of *diardii* is completely dominant over the white colour of *jalorensis*. However, as no F_2 or back-cross offspring could be obtained it is not possible to work out the actual segregation for this character. Mathews (1952) says that breeding experiments have shown that the light ventral colour of *R. r. frugivorus* is a simple Mendelian dominant over the dusky ventral surface of *R. r. alexandrinus*—the Roof Rat. This system seems to be the reverse that observed in *diardii* and *jalorensis*.

R. r. frugivorous is known to have been introduced into Singapore through shipping. As the light ventral colour of *frugivorous* is dominant over the dark ventral colour of *alexandrinus,* it is possible that *frugivorous* may have crossed with *diardii* in Singapore, thus giving rise to some *diardii* with very light-coloured ventral surface. *Diardii* rats with very light ventral surfaces were caught from the city and around the harbour area of Singapore. This may explain the absence of similar light-bellied *diardii* rats collected in central Malaya.

Singapore and South Johore *jalorensis* differ considerably in their dorsal colour from Kuala Lumpur *jalorensis*.

It has been suggested that a cline in dorsal colour extends from the dark backed *R. r. rhionis* in islands to the south of Singapore through *jalorensis* in the Malay Peninsula into the lighter-backed *R. r. tikos* and *R. r. thai* of Siam (Dhaliwal, 1961).

Schwarz and Schwarz (1943) compared the wild and commensal species of *Mus* and found that all wild forms of the mouse had tails shorter than the head and body and were white ventrally with a sharp line of demarcation at the sides. In commensals there is a trend towards elongation of tail and a change to darker belly colour. This compares well with the relationship between *diardii* and *jalorensis*. In the Field Rat *jalorensis* the tail is shorter than head and body (unpublished data) and the ventral surface is white with a sharp line of demarcation. In the House Rat *diardii* the tail is longer than head and body (unpublished data) and the ventral body surface is darker in colour.

It is particularly to be noted that all the commensal forms in rats and mice have darker ventral surfaces than the corresponding wild forms. This is so in *alexandrinus,* the Roof Rat, compared with *frugivorous,* the Tree Rat, in the commensal and wild forms of *Mus,* and in *diardii* and *jalorensis*. Obviously, the dark ventral body colour has a great advantage to rats and mice living in houses. It is possible that the dark ventral surface makes them less conspicuous, especially when they are running on beams across roofs, etc.

Dry (1926) gave the percentages for the types of hair found in the coats of the normal mouse. According to him guard hairs form 2% of the coat, awls (including auchenes) 28% and zigzags the remaining 70%. Dry does not consider auchenes as distinct from awls. Both *diardii* and *jalorensis* have less guard hairs than the mouse. The percentage of spines and auchenes in these rats (7%–22%) is much less than the percentage of awls (including auchenes) in the mouse. Again the percentage of zigzags (75%–92%) is higher than that in the mouse.

Some differences were found between the two subspecies in the microscopical structure of the ventral hair. Both zigzags and auchenes from the ventral surface of *jalorensis* had no pigment granules along the whole length of the hair. The same types of hair from the ventral surface of *diardii* had large numbers of pigment guanules.

However, because of the large variation in ventral colour of *diardii*, it was found that the amount of pigment in the ventral hair of *diardii* was highly variable. Ventral spines from *jalorensis* had some pigment granules. The absence of pigment granules in ventral auchenes and zigzags of *jalorensis* accounts for its white ventral colour. The few pigment granules in the ventral spines will not make much difference as spines form only about 2% of the ventral hair.

In conclusion, it can be said that the two subspecies hybridized in the laboratory although the behaviour of the rats in the hybrid crosses suggests that they are not likely to hybridize in nature. The hybrids appeared to be sterile although this was not conclusively proven. The outstanding difference in ventral pelage colour between the two rats is genetically controlled and is likely to be inherited in a simple Mendelian fashion. The basis of this difference has been shown to be the absence of pigment granules in two types of ventral hair which form the main part of the coat. Further morphological differences between the two subspecies and the final conclusions on their systematic status will be reported in a following paper.

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Helminth parasites of some Malayan fresh-water fishes

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INTRODUCTION

NO HELMINTH PARASITES have so far been recorded in Malayan freshwater fishes. In a preliminary investigation, we have examined sixteen species of fish from Singapore, Malacca and Seremban. The present paper is a record of the species found. Ten species of helminths comprising three cestodes, six nematodes and one acanthocephalan are recorded. Of these ten species six are new. The ten species herein recorded are: *Senga malayana* sp. nov., *S. parva* sp. nov., and *S. filiformis* sp. nov. (Cestoda); *Camallanus yehi* sp. nov., *C. longitridentatus* sp. nov., *Zeylanema anabantis* (Pearse), *Z. pearsei* Yeh, *Procamallanus clarius* Ali, and *P. malaccensis* sp. nov. (Nematoda); and *Pallisentis gaboes* (MacCallum) (Acanthocephala).

MATERIALS AND METHODS

Sixteen species of freshwater fish were examined, namely, *Channa striata* (Bloch), *C. micropeltes* (Cuv.), *C. lucius* (Cuv.), *Anabas testudineus* (Bloch), *Trichogaster pectoralis* (Regan), *T. trichopterus* (Pallas), *Clarias batrachus* (L.), *Ctenopharyngodon idellus* Cuv., *Puntius gonionotus* (Bleeker), *P. binotatus* (Val.), *Cyclocheilichthys apogon* (Val.), *Monopterus albus* (Zuiew), *Notopterus notopterus* (Pallas), *Tilapia mossambica* (Peters), *T. zillii* (Gerv.), and *Oxyeleotris marmorata* (Bleeker). The fish were collected or purchased at Malacca, Seremban (Negri Sembilan) and Singapore.

The nematodes were collected in saline and fixed in warm 70% alcohol. They were stored in 70% alcohol. They were examined in Amman's lactophenol, which gave good results.

The cestodes were fixed in Bouin's fluid. Whole mounts were stained in Delafield's haematoxylin or borax carmine. Sections were stained in Heidenhain's iron haematoxylin.

The acanthocephalans were fixed in Bouin's fluid, after slight pressure had been exerted to evert the proboscis. Whole mounts were stained in Delafield's haematoxylin or borax carmine.

CESTODA

Three species belonging to the family Ptychobothriidae, genus *Senga* Dollfus 1934, were found. They are all new and have been named *Senga malayana* sp. nov., *S. parva* sp. nov. and *S. filiformis* sp. nov.

Senga malayana sp. nov.

Seventeen specimens were obtained from the small intestine of a *Channa striata* in Batu Berendam, Malacca, on 6-10-1961.

Description.—They measure 9.7–73.8[1] in length and 0.70–3.10 in maximum breadth. The body has a general *Taenia*-like shape (Fig. 2) with the proglottids increasing in breadth towards the posterior. The scolex is typical of the genus *Senga,* and consists of an armed apical disc and a pair of shallow bothria.

The scolex is somewhat rectangular in shape, and measures 0.679–1.797 in length and 0.242–0.350 in maximum breadth. The bothria extend to about three-fourths the length of the scolex (Fig. 2). The bothrium is ovoid, and slightly broader at the base. It measures 0.494–0.919 in length and 0.200–0.225 in maximum breadth. The bothrium is fleshy and the margins of the shallow groove are thickened. In transverse section, the scolex in the region of the bothrium is somewhat H-shaped (Fig. 5). It is muscular bearing two (dorsal and ventral) groups of longitudinal muscles, on the outside of which are circular muscles, and running dorso-ventrally are transverse muscles. A pair of excretory canals are present on the outside of which are the slightly larger nerve cords. Darkly staining lime cells are scattered in the parenchyma, mainly in the cortex. In transverse section, the scolex below the bothrium appears more or less circular (Fig. 6). The longitudinal muscles are very prominent and arranged in two (dorsal and ventral) elliptical areas. In addition there are muscles radiating outward, and two pairs of excretory ducts and a pair of nerve cords in the medulla.

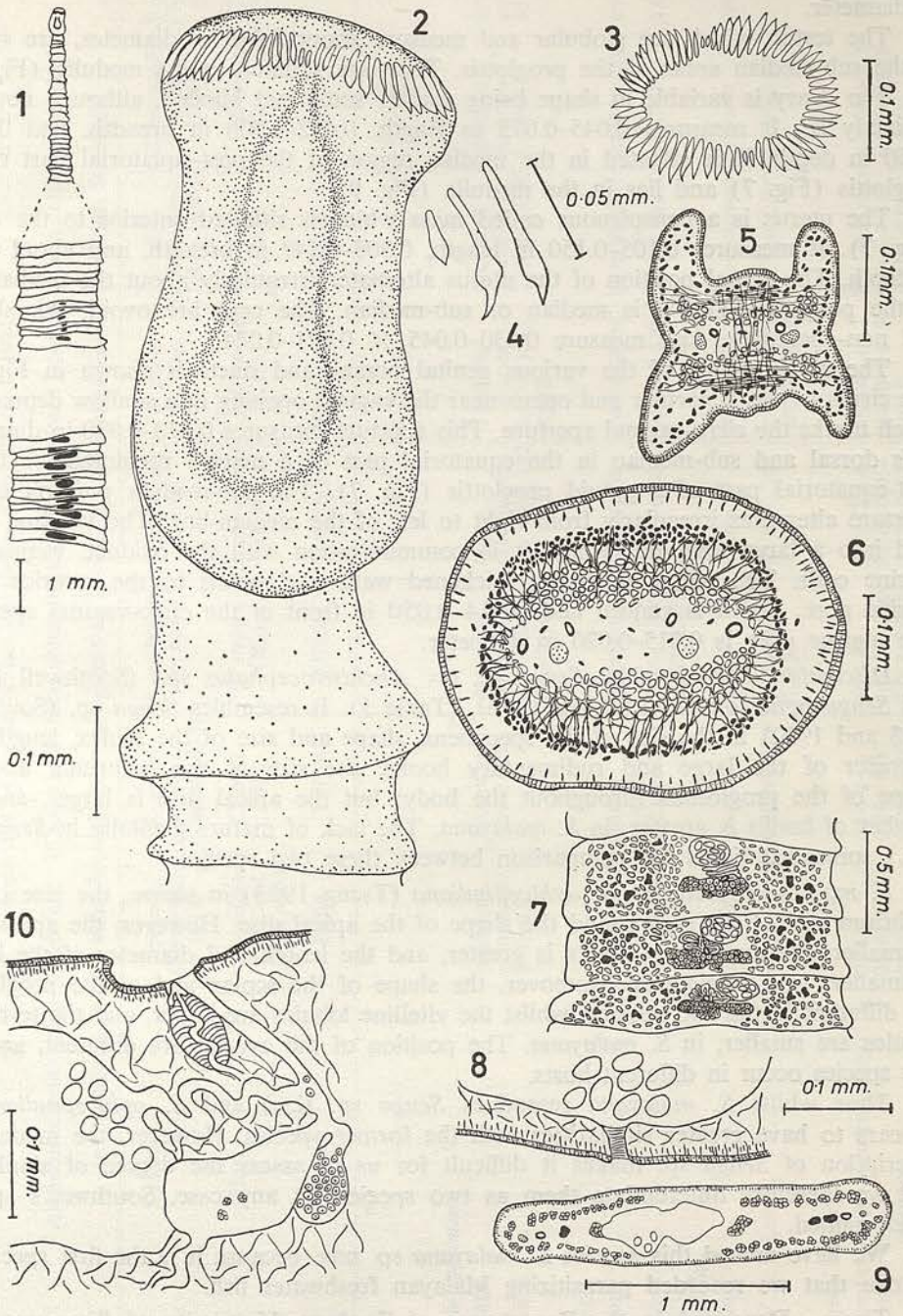
The apical disc is ovoid in shape and is interrupted mid-dorsally and -ventrally by a notch, which represents the anterior opening of the bothrial slit (Fig. 3). The disc measures 0.154 between the notches, and 0.225–0.315 along the lateral axis. It is raised at the centre, about 0.036–0.048 above the base of the hooks.

The margin of the apical disc bears a crown of 56 large and 4 rudimentary hooks (Fig. 3); a pair of the latter is situated in each notch and divides the distribution of the large hooks into two semi-circles. The large hooks measure 0.045–0.060 in length, and increase in size away from the notches reaching their maximum length at the lateral apex of the discal margin. The rudimentary hooks measure 0.018–0.024 in length. The maximum diameter of all hooks is 0.006–0.009. The hooks vary somewhat in shape (Fig. 4). The large hooks are pointed distally, and on the distal side of the mid-length they enter into a bulge, from where they narrow in diameter towards the blunt, obtuse base. The rudimentary hooks are somewhat spatulate in shape, and pointed distally.

The proglottids vary in number from about a hundred to about five hundred or more. They vary in distinctness. The early proglottids are distinct, but somewhere between the 6th–12th proglottis the segmentation becomes less distinct and a single external segment may contain two proglottids, which may be superficially demarcated by a furrow that extends a short distance from the lateral margin. The mature and gravid proglottids are very indistinct. All the proglottids are acraspedote. The proglottids vary considerably in size. They are all rectangular in shape, and are usually broader than long. They measure: 0.077 × 0.554 — 0.169 × 0.262 for the first, 0.123 × 0.323 — 0.185 × 0.185 for the tenth, 0.077 × 0.431 — 0.185 × 0.216 for the twentieth, 0.092 × 0.431 — 0.231 × 0.264 for the thirtieth, proglottis. The genitalia begin to mature between the 100th and the 130th proglottids which measure 0.139 × 0.970 — 0.200 × 0.600. Gravid proglottids measure about 0.4 in length and 1.5 in breadth.

[1] All measurements given in this paper are in millimetres.

In transverse section, the parenchyma in the proglottis consists of a narrow medullary region, which is separated from the cortex by fine circular muscles; the longitudinal muscles are situated in the cortex only.



Figures 1–10. *Senga malayana* sp. nov. (1) General view of scolex and proglottids. (2) Scolex. (3) Apical disc showing the arrangement of hooks (en face mount). (4) Hooks. (5) T.S. in region of bothria. (6) T.S. of post-bothrial region of the scolex. (7) Mature proglottids. (8) Uterine opening. (9) T.S. of mature proglottis. (10) Diagram to illustrate the relationship of the sexual organs.

The vitellaria are situated in two cortical groups, which are separated in the mid-dorsal and mid-ventral areas (Fig. 9). The vitelline cells are grouped into lobules, which spread throughout the extent of the proglottis and, which measure about 0.060 in diameter.

The testes, which are globular and measure about 0.045 in diameter, are spread in the sub-median areas of the proglottis. They are situated in the medulla (Fig. 9).

The ovary is variable in shape being usually somewhat bilobed, although not very distinctly so. It measures 0.045–0.075 in length, 0.462–0.900 in breadth, and 0.045–0.060 in depth. It is situated in the median region of the post-equatorial part of the proglottis (Fig. 7) and lies in the medulla (Fig. 9).

The uterus is a conspicuous coiled mass which is situated anterior to the ovary (Fig. 7). It measures 0.105–0.150 in length, 0.308–0.549 in breadth, and about 0.230 in depth. The actual position of the uterus alternates irregularly about the median-line of the proglottis, and it is median or sub-median. The eggs are ovoid, thin-shelled and non-operculate, and measure 0.030–0.045 × 0.021–0.024.

The relationships of the various genital organs and ducts is shown in Fig. 10. The cirrus is very muscular and opens near the vaginal opening in a shallow depression, which marks the cirro-vaginal aperture. This aperture measures 0.020–0.030 in diameter. It is dorsal and sub-median in the equatorial part of a mature proglottis, or in the post-equatorial part of a gravid proglottis (Fig. 7). The sub-median position of the aperture alternates irregularly from right to left of the median-line. The vitelline ducts lead into a large reservoir, which is in communication with the oviduct, vagina and uterine coils. The uterus possesses thickened walls and opens to the exterior by a uterine pore, which is ventral and 0.014–0.050 in front of the cirro-vaginal aperture. The uterine pore is 0.015–0.020 in diameter.

Discussion.—It resembles *Senga* sp. (= *Anchistrocephalus* sp.) (Southwell 1913) and *Senga ophicephaliana* (Tseng 1933), (Table 1). It resembles *Senga* sp. (Southwell 1913 and 1930) in the size of the specimens, shape and size of the scolex, length and diameter of the large and rudimentary hooks, the size of the bothrium, and the shape of the proglottids throughout the body; but the apical disc is larger, and the number of hooks is greater, in *S. malayana*. The lack of mature genitalia in *Senga* sp. (l.c.) somewhat limits the comparison between these two species.

S. malayana resembles *S. ophicephaliana* (Tseng 1933) in shape, the size of the bothrium and of the scolex, and the shape of the apical disc. However, the apical disc is smaller, the number of hooks is greater, and the length and diameter of the hooks is smaller, in *S. malayana*. Moreover, the shape of the scolex and of the proglottids are different in the two species; whilst the vitelline lobules are larger, and the testicular lobules are smaller, in *S. malayana*. The position of the ovaries are different, and the two species occur in different hosts.

Thus whilst *S. malayana* resembles *Senga* sp. (l.c.) and *S. ophicephaliana,* it appears to have greater similarities with the former species. However, the inadequate description of *Senga* sp. makes it difficult for us to assess the degree of similarity; and we therefore differentiate them as two species. In any case, Southwell's species is not named.

We have named this species *S. malayana* sp. nov. because it is the first species of cestode that we recorded parasitizing Malayan freshwater fish.

Types.—Deposited in the Department of Zoology, University of Singapore, and the British Museum (Natural History), London.

TABLE 1

Comparison of species within the Genus *Senga* Dollfus, 1934.

All measurements are in millimeters. In some cases measurements have been calculated from the figures in the original texts.

ant.=anterior, B=maximum breadth, DV=dorso-ventral, L=length, Lat.=lateral, post.=posterior, Sl.=slight

Species	*Senga sp.* (Southwell, 1913)	*S. ophicephaliana* (Tseng, 1933)	*S. malayana* sp. nov.	*S. filiformis* sp. nov.	*S. parva* sp. nov.	*S. lucknowensis* (Johri, 1936)	*S. besnardi* (Dollfus, 1934)	*S. pycnomera* (Woodland, 1924)
Host	*C. striata* (Bl.) and *Labeo rohita*	*C. arga* Cant.	*C. striata* (Bl.)	*C. micropeltes* (Cuv.)	*C. micropeltes* (Cuv.)	*M. armatus* (Lac.)	*B. splendens* Reg.	*C. marulia* (H.B.)
Locality	India	Tsinan	Malacca	Singapore	Singapore	India	Siam	India
Whole specimens								
Shape	broadens posteriorly	broadens posteriorly	broadens posteriorly	tapers posteriorly	spindle-shaped	broadens posteriorly	broadens posteriorly	broadens posteriorly
L. x B.	17.0x0.8	?	9.7–73.8x 0.70–3.10	15–16x0.192	5.17x0.362–0.832	210–212×18	5–15x0.8	45–120x2–3
Scolex								
Shape	rectangular	bottle-shaped	rectangular	rectangular	pear-shaped	pear-shaped	rectangular	oviod
L. x B.	1.0x0.45	1.132x0.366	0.679–1.797x 0.242–0.350	0.640–0.300	0.460–0.530	1.24–1.95x10	0.687x0.35	1.095x0.713
Apical disc								
Shape	circular	ovoid	ovoid	ovoid	figure–8	two ½ crowns	circular	ovoid
DV. L. x Lat. L.	0.110x0.105	0.200x0.344	0.154x0.225–0.315	0.150x0.200	0.105–0.120 x0.120–0.300	0.250x0.250	0.120x0.120	?
Marginal hooks								
Number (large + rudimentary) ..	52+4	53+4	56+4	51–52+4	38–40+4	36–48(total)	43–44+1–3	68
L. of large	0.043–0.071	0.144–0.177	0.045–0.060	0.048–0.064	0.030–0.075	0.060–0.079	0.027–0.035	?
L. of rudimentary	0.014	0.033–0.099	0.018–0.024	0.030–0.032	0.015	0.020–0.050	0.010	?
Diameter	0.005	0.011–0.033	0.006–0.009	0.005–0.015	0.010–0.015	0.004–0.015	0.003–0.006	0.029–0.075

Mus. 32, 1963.

TABLE 1—*continued*

Species	*Senga sp.* (Southwell, 1913)	*S. ophicephaliana* (Tseng, 1933)	*S. malayana* sp. nov.	*S. filiformis* sp. nov.	*S. parva* sp. nov.	*S. lucknowensis* Johri, 1936	*S. besnardi* Dollfus, 1934	*S. pycnomera* (Woodland, 1924)
Host	*C. striata* (Bl.) and *Labeo rohita*	*C. arga* Cant.	*C. striata* (Bl.)	*C. micropeltes* (Cuv.)	*C. micropeltes* (Cuv.)	*M. armatus* (Lac.)	*B. splendens* Reg.	*C. marulia* (H.B.)
Locality	India	Tsinan	Malacca	Singapore	Singapore	India	Siam	India
Bothrium								
Bothrium:Scolex	3:4 to > 1	3:4	3:4	3:4	3:4 to > 1	3:4	1:2	3:4
L. x B.	0.307–?x?	0.854x0.366	0.494–0.919x 0.200–0.225	0.480x?	0.462–0.465 x0.150	0.86–1.25x?	0.375x0.35	.055x?
Proglottids								
Segmentation	distinct	distinct	distinct and indistinct	distinct	distinct and indistinct	distinct and indistinct	indistinct	indistinct
Shape (ant. to post.) L: B ..	B=L to B> L	B > L	B=L to B> L	B> L to B= L to L> B	B> L to L =B	B> L	B> L to B= L to L> B	B > L
Vitellaria								
Cells	?	lobulate	lobulate	separate	separate	lobulate	?	?
Diameter	?	0.022–0.033	0.060	0.005		0.1		
Spread	?	?	discontinuous; in 2 groups	continuous	continuous	discontinuous; in 2 groups	continuous	discontinuous; in 2 groups
Testes								
Diameter	?	0.055–0.077	0.045	0.016	?	0.040–0.046	?	?
Ovary								
Shape	?	bilobed	sl. bilobed	globular	globular	bilobed	lobulate	bilobed
Position	?	equatorial	post-equatorial	post-equatorial	antero-equatorial	post-equatorial	post-equatorial	post-equatorial
Eggs								
L. x B.	?	?	0.030–0.045 x0.021–0.024	?	?	0.046–0.060 x0.024–0.038	0.039x0.028 –0.024x0.029	0.044x0.025

Senga parva sp. nov.

More than 500 specimens were obtained from the intestine of three *Channa micropeltes*, which were purchased in Singapore on 28-4-1961. The fish are supposed to have been imported from Palembang, Sumatra; but since dealer's localities are notorious for their inaccuracy, it is likely that the fish came from Malaya where this species is common.

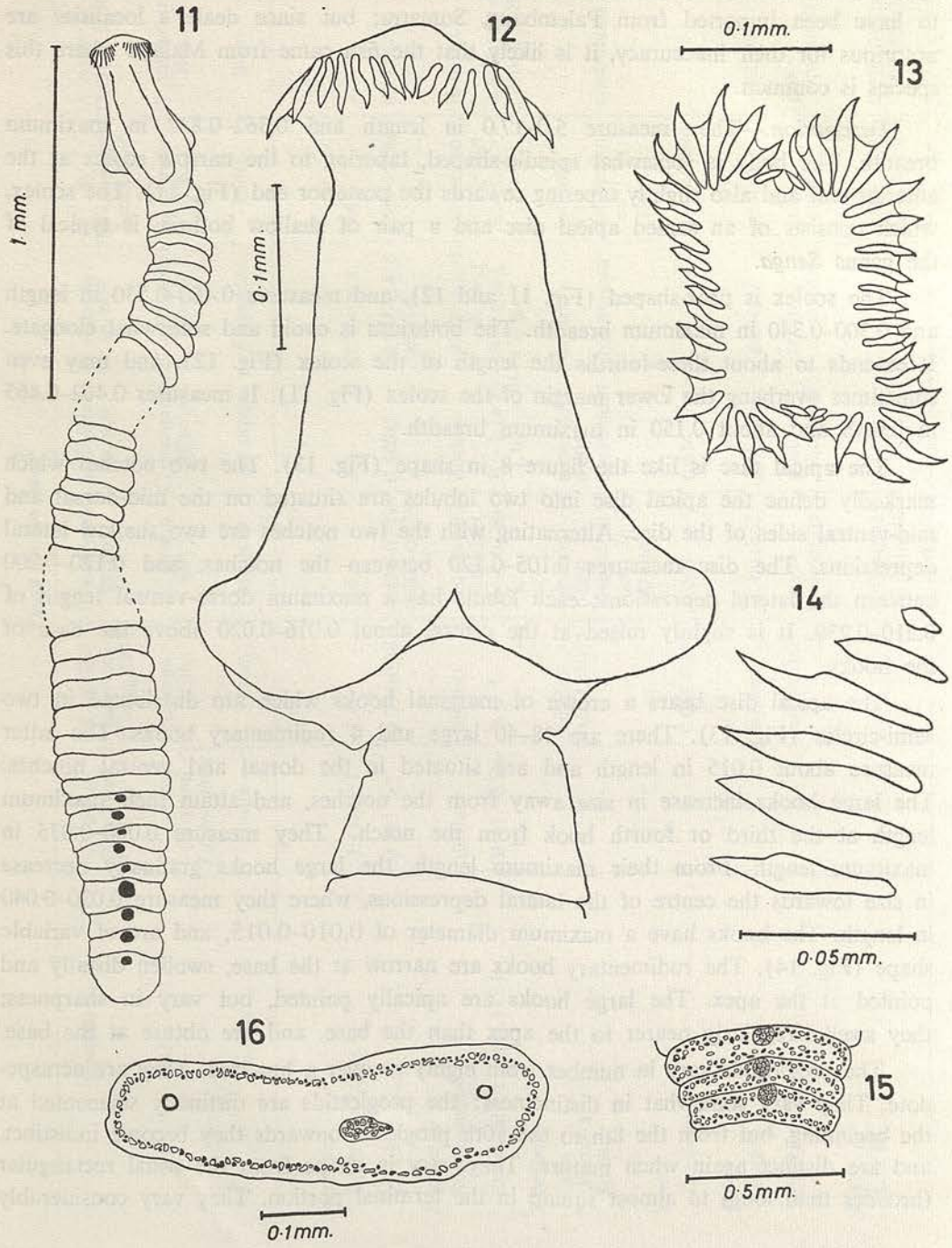
Description.—They measure 5.0–17.0 in length and 0.362–0.832 in maximum breadth. The body is somewhat spindle-shaped, tapering to the narrow scolex at the anterior end and also slightly tapering towards the posterior end (Fig. 11). The scolex, which consists of an armed apical disc and a pair of shallow bothria, is typical of the genus *Senga*.

The scolex is pear-shaped (Fig. 11 and 12), and measures 0.460–0.530 in length and 0.300–0.340 in maximum breadth. The bothrium is ovoid and somewhat elongate. It extends to about three-fourths the length of the scolex (Fig. 12), and may even sometimes overhang the lower margin of the scolex (Fig. 11). It measures 0.462–0.465 in length and about 0.150 in maximum breadth.

The apical disc is like the figure 8 in shape (Fig. 13). The two notches which markedly define the apical disc into two lobules are situated on the mid-dorsal and mid-ventral sides of the disc. Alternating with the two notches are two shallow lateral depressions. The disc measures 0.105–0.120 between the notches, and 0.120–0.200 between the lateral depressions; each lobule has a maximum dorso-ventral length of 0.210–0.230. It is slightly raised at the centre, about 0.016–0.020 above the base of the hooks.

The apical disc bears a crown of marginal hooks which are distributed in two semi-circles (Fig. 13). There are 38–40 large and 4 rudimentary hooks. The latter measure about 0.015 in length and are situated in the dorsal and ventral notches. The large hooks increase in size away from the notches, and attain their maximum length at the third or fourth hook from the notch. They measure 0.060–0.075 in maximum length. From their maximum length, the large hooks gradually decrease in size towards the centre of the lateral depressions, where they measure 0.030–0.040 in length. The hooks have a maximum diameter of 0.010–0.015, and are of variable shape (Fig. 14). The rudimentary hooks are narrow at the base, swollen distally and pointed at the apex. The large hooks are apically pointed, but vary in sharpness; they swell irregularly nearer to the apex than the base, and are obtuse at the base.

The proglottids vary in number from eighty to over a hundred. They are acraspedote. They vary somewhat in distinctness: the proglottids are distinctly segmented at the beginning, but from the 8th to the 10th proglottis onwards they become indistinct, and are distinct again when mature. They vary in shape from the usual rectangular (broader than long) to almost square in the terminal portion. They vary considerably



Figures 11–16. *Senga parva* sp. nov. (11) General view of scolex and proglottids. (12) Scolex. (13) Apical disc showing the arrangement of hooks (en face mount). (14) Hooks. (15) Mature proglottids. (16) T.S. of proglottis.

in size: 0.030 × 0.090 — 0.075 × 0.150 in the first, 0.075 × 0.150 — 0.060 × 0.350 in the tenth, 0.045 × 0.165 — 0.060 × 0.330 in the twentieth, and 0.060 × 0.150 — 0.030 × 0.400 in the thirtieth, proglottis. The genitalia begin to mature between the 160th and 180th proglottis, which measure about 0.050 × 0.200. The terminal proglottis at the posterior measures 0.160 × 0.260 — 0.250 × 0.260.

The vitellaria form a continuous layer in the cortex (Fig. 16). The vitelline cells are not grouped into lobules (as in *S. malayana*); but this may be due to the relative immaturity of the specimens.

The ovary is a single globular mass with a diameter of 0.050 — 0.100. In our specimens it is rudimentary in development. But it is situated in the medulla (Fig. 16), and occupies a median position in the antero-equatorial part of the proglottis (Fig. 16).

The rest of the genitalia were not visible since the specimens were relatively immature.

The worms were very mobile and showed a considerable range of change in shape when alive. The pear-shaped scolex also showed a considerable change in shape: it can be retracted until the hooks almost reach the base, whence it is broad and rounded, and it can be extended to a relatively narrow shape with the hooks far removed from the base.

Discussion.—This species differs from all the previously described species of *Senga* in the shape of the scolex, the number of hooks, and the anatomy of the proglottids. It resembles *Senga lucknowensis* Johri (1956) (Table 1). The two species are similar in the shape of the scolex and of the proglottids, the shape of the apical disc, the number of hooks, and the type of segmentation. However they differ from each other in several aspects: the body is spindle-shaped and smaller in size, the scolex is a third and the apical disc is a half smaller in size, the length of the hooks is somewhat smaller although their diameter is slightly larger, the bothrium is as half as small, the vitelline cells are not grouped into lobules and are continuously extended, and the ovary is globular and occupies the antero-equatorial part of the proglottis, in *Senga parva.* From these overall differences it is evident that *S. parva* is a species distinct from *S. lucknowensis.*

We have named this species *Senga parva* sp. nov. because of its small size. In size it approaches *S. besnardi* Dollfus, which is somewhat smaller than it and which is the smallest species of *Senga* so far recorded.

Types.—Deposited in the Department of Zoology, University of Singapore, and the British Museum (Natural History), London.

Senga filiformis sp. nov.

Four specimens were obtained from the intestines of three *Channa micropeltes,* which were purchased in Singapore on 28-4-1961. The doubtful accuracy of the locality, namely, Palembang, Sumatra, has already been stated.

Description.—They measure 15–16 in length and about 0.192 in maximum breadth. The body is thread-like and tapers gradually towards the posterior (Fig. 17). The scolex, which possesses an armed apical disc and a pair of shallow bothria, is typical of the genus *Senga*.

The scolex is somewhat rectangular and is widest three-fourths from the anterior end (Fig. 17); but it is not markedly pear-shaped as in *S. parva* sp. nov. It measures about 0.640 in length and 0.300–0.320 in maximum breadth. The bothrium is shallow, which is typical for this genus, and extends to about three-fourths the length of the scolex. It measures about 0.480 in length.

The apical disc is somewhat 8-shaped, with a notch on the dorsal and ventral sides (Fig. 18). It measures about 0.200 along its lateral axis, and about 0.150 between the notches. It is raised centrally, about 0.015 above the base of the hooks.

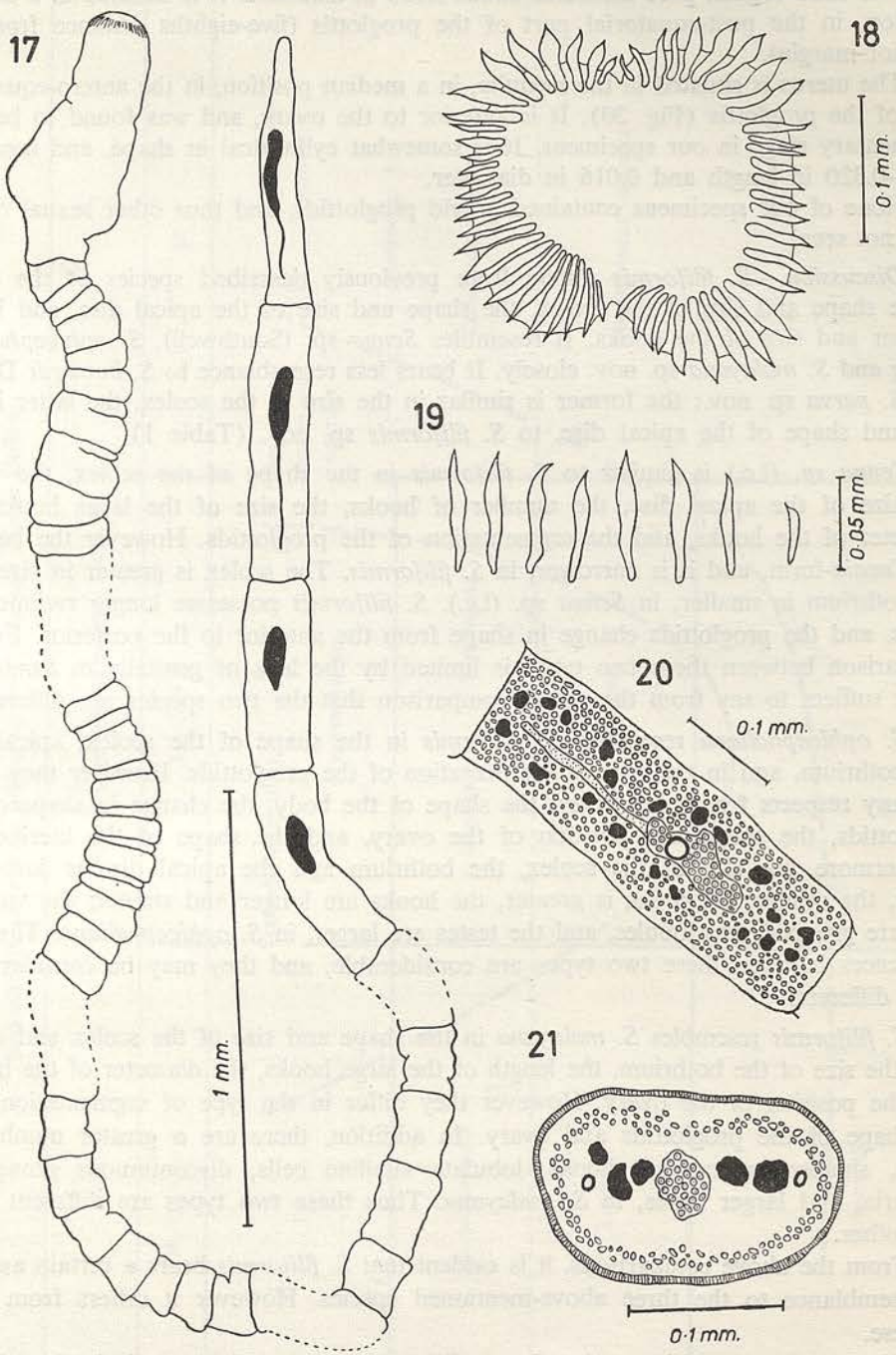
The apical disc is marginally armed with 51–52 large and 4 rudimentary hooks, which are distributed in two semi-circles (Fig. 18). The distribution of the large hooks is interrupted at the notches, in which the rudimentary hooks are situated. The large hooks increase in size away from the notches, and reach their maximum length between the 5th, and the 8th hook from the notch. The hooks then decrease in size gradually towards the apex of the semi-circle. The large hooks measure 0.048–0.064 in length, whilst the rudimentary hooks measure 0.030–0.032. The hooks vary considerably in shape (Fig. 19). The rudimentary hooks are pointed at the tip, and slightly enlarged at the distal end. The large hooks are pointed at the tip and enlarged in the distal half; they range from narrow to stout, and from straight to slightly sinuous.

The proglottids vary in number, and differ markedly in size. There are more than seventy proglottids. They are rectangular in shape but vary in size from laterally elongated to antero-posteriorly elongated proglottids. They measure: 0.096 × 0.144 in the first, 0.064 × 0.200 — 0.032 × 0.160 in the tenth, 0.080 × 0.200 — 0.032 × 0.160 in the twentieth, and 0.064 × 0.160 — 0.032 × 0.130 in the thirtieth, proglottis. The genitalia show maturity between the 50th and 60th proglottis, which measure 0.350 × 0.160 — 0.240 × 0.145. The terminal proglottis measures 0.670 × 0.112 — 0.480 × 0.160. The proglottids have a thickness of about 0.130. They are all acraspedote, and exhibit distinct segmentation throughout the body.

The vitelline cells are not grouped into lobules and measure 0.004–0.006 in diameter. They are interspersed with longitudinal muscles, and form a continuous layer in the cortex (Fig. 21).

There are 17–21 or more testicular lobules, which measure 0.016 in diameter. They are scattered throughout the proglottis (Fig. 20) and are situated in the medulla.

The ovary is single and ovoid. It measures 0.080–0.200 in length, 0.030–0.050 in maximum breadth, and about 0.030 in maximum thickness. It is situated in the medulla, and lies in a median position in the post-equatorial part of the proglottis (Fig. 20 & 21).



Figures 17–21. *Senga filiformis* sp. nov. (17) General view of scolex and proglottids. (18) Apical disc showing the arrangement of hooks (en face mount). (19) Hooks. (20) Mature proglottids. (21) T. S. of mature proglottis.

The cirro-vaginal pore measures about 0.030 in diameter. It is situated in a median position, in the post-equatorial part of the proglottis (five-eighths distance from the anterior margin).

The uterus is situated in the medulla, in a median position, in the antero-equatorial part of the proglottis (Fig. 20). It is anterior to the ovary, and was found to be in a rudimentary stage in our specimens. It is somewhat cylindrical in shape, and measures 0.160–0.320 in length and 0.016 in diameter.

None of our specimens contained gravid proglottids, and thus other sexual organs were not seen.

Discussion.—*S. filiformis* differs from previously described species of the genus in the shape and size of the scolex, the shape and size of the apical disc, and in the number and size of the hooks. It resembles *Senga* sp. (Southwell), *S. ophicephaliana* Tseng and *S. malayana* sp. nov. closely. It bears less resemblance to *S. besnardi* Dollfus and *S. parva* sp. nov.; the former is similar in the size of the scolex, the latter in the size and shape of the apical disc, to *S. filiformis* sp. nov. (Table 1).

Senga sp. (l.c.) is similar to *S. filiformis* in the shape of the scolex, the shape and size of the apical disc, the number of hooks, the size of the large hooks, the diameter of the hooks, and the segmentation of the proglottids. However the body is not *Taenia*-form, and it is narrower, in *S. filiformis*. The scolex is greater in size, and the bothrium is smaller, in *Senga* sp. (l.c.). *S. filiformis* possesses longer rudimentary hooks, and the proglottids change in shape from the anterior to the posterior. Further comparison between these two types is limited by the lack of genitalia in *Senga* sp.; but it suffices to say from the above comparison that the two species are different.

S. ophicephaliana resembles *S. filiformis* in the shape of the scolex, apical disc and bothrium, and in the type of segmentation of the proglottids. However they differ in many respects from each other; the shape of the body, the change in shape of the proglottids, the shape and position of the ovary, and the shape of the uterine sac. Furthermore, the size of the scolex, the bothrium and the apical disc is somewhat larger, the number of hooks is greater, the hooks are longer and stouter, the vitelline cells are grouped into lobules, and the testes are larger, in *S. ophicephaliana*. Thus the differences between these two types are considerable, and they may be considered as being different.

S. filiformis resembles *S. malayana* in the shape and size of the scolex and apical disc, the size of the bothrium, the length of the large hooks, the diameter of the hooks, and the position of the ovary. However they differ in the type of segmentation, and the shape of the proglottids and ovary. In addition, there are a greater number of hooks, shorter rudimentary hooks, lobulate vitelline cells, discontinuous groups of vitellaria, and larger testes, in *S. malayana*. Thus these two types are different from each other.

From the above comparisons, it is evident that *S. filiformis* bears a certain amount of resemblance to the three above-mentioned species. However it differs from each of these.

We have named this species *Senga filiformis* sp. nov. because it is thread-like; it is the narrowest species of *Senga* so far recorded.

Types.—Deposited in the Department of Zoology, University of Singapore.

TABLE 2

Relationship of species belonging to the Genus *Senga* Dollfus

Number of large and rudimentary hooks		
38—48+1—4	51—56+4	68
Segments all distinct	Segments distinct and indistinct	Segments all indistinct
S. ophicephaliana	*Senga sp.*	*S. pycnomera ?*
S. lucknowensis	*S. malayana*	Continuous vitellaria
S. parva	*S. filiformis*	Discontinuous vitellaria
S. besnardi		

Length of large hooks (mm)

0·080

0·040

General discussion and key to the Genus *Senga* Dollfus

The genus *Senga* was erected by Dollfus (1934) to accommodate *S. besnardi* Dollfus 1934, and *S. ophicephaliana* (Tseng). It also includes as a doubtful member *S. pycnomera* (Woodland); and Johri (1956) has added another species to this genus, *S. lucknowensis.*

The first description of a member of this genus was Southwell's *Ancistrocephalus* sp. (Southwell 1913), obtained from *Channa striata* and *Labeo rohita.* Tseng (1933) described *Ancistrocephalus ophicephalianus* from *Channa argus* (Cantor) in Tsinan. On gross similarities between Southwell's description and his own specimens, Tseng included Southwell's species with his own. However, Tseng had not examined Southwell's specimens. We have not examined Southwell's nor Tseng's specimens; but have calculated additional characteristics and measurements for their specimens, from figures published in their original descriptions. With this data we find that Southwell's species is different from Tseng's. The apical disc is larger, the hooks are longer and stouter, and the bothrium is larger, in *S. ophicephaliana.* The lack of further anatomical detail in Southwell's species somewhat limits the comparison. But it appears (Table 1) that Southwell's species is different from Tseng's; in fact, it bears greater similarity to *S. malayana* than to *S. ophicephaliana.* However it would be improper for us to lump Southwell's species with *S. malayana;* and it is best in this position, to keep Southwell's species distinct from the rest until extensive, and intensive, studies of this genus have been made in India, China and South East Asia.

The anatomy of the genus is at present poorly known. Diagnosis of species is therefore difficult. It is likely that the number and size of hooks, their shape and distribution on the apical cone, may be reliable diagnostic features. The shape of the scolex is variable, but offers some basis for species diagnosis. But the shape of the proglottids is very variable even in the same specimen; and it is therefore difficult to use this character without extensive detailed studies within the genus. Little is known about the reproductive system within this genus. This is a serious handicap to the use of their structural peculiarities for specific diagnosis.

Under these circumstances, we have relied on a complex of characters; the shape and size of the scolex and bothria, the number and size of hooks, the shape and size of the apical disc, and the general structure of the proglottids. Where material was available we have studied the detailed internal anatomy of mature proglottids, which gives a clue to specific diagnosis. On this basis, the three new species of Senga described by us are different from previously known ones.

The following is a key to the hitherto known species of the genus *Senga*, including the three new Malayan species:—

1 a. 35–52 large and rudimentary hooks ..... 2.

b. 55–60 large and rudimentary hooks ..... 4.

c. More than 65 large and rudimentary hooks; 68 hooks; hooks long and stout (0.029–0.075); vitellaria discontinuous; relatively large worms ..... *S. pycnomera* (Woodland 1924).

2 a. Scolex pear-shaped; bothrium occupies three-fourths or more of scolex; large hooks relatively long (0.030–0.079) ..... 3.

b. Scolex rectangular; 43–44 large and 1–3 rudimentary hooks; large hooks relatively small (0.027–0.035); bothrium occupies half the length of the scolex; vitellaria continuous ..... *S. besnardi* Dollfus 1934.

3 a. Body somewhat spindle-shaped; 38–40 large and rudimentary hooks; vitelline cells separate; vitellaria continuous; ovary globular, antero-equatorial; scolex relatively small (0.460–0.530); worms relatively small (5–17) ..... *S. parva* sp. nov.

b. Body Taenia-like; 36–48 hooks; vitelline cells lobulate; vitellaria discontinuous; ovary bilobed, post-equatorial; scolex relatively long (1.24–1.95); worms relatively large (210–212) ..... *S. lucknowensis* Johri 1956.

4 a. Body *Taenia*-like, broadens posteriorly ..... 5.

b. Body filiform (0.192 broad), tapers posteriorly; proglottids become longer than broad towards the posterior end; 52–53 large and 4 rudimentary hooks; vitelline cells not lobulate; vitellaria continuous; ovary globular, post-equatorial; uterine sac cylindrical ..... *S. filiformis* sp. nov.

5 a. Large (0.043–0.071) and rudimentary (0.014–0.024) hooks comparatively short, and narrow (0.005–0.009); apical disc comparatively small ..... 6.

b. Large (0.114–0.177) and rudimentary (0.033–0.099) hooks comparatively long, and stout (0.011–0.033); 53 large and 4 rudimentary hooks; vitelline cells lobulate; ovary bilobed, equatorial; apical disc comparatively large (0.200×0.344) .... *S. ophicephaliana* Tseng 1933.

6 a. 52 large and 4 rudimentary hooks; bothrium comparatively short (0.307); apical disc 0.110×0.105; segmentation of proglottids distinct ..... *Senga* sp. (Southwell 1913).

b. 56 large and 4 rudimentary hooks; bothrium comparatively long (0.494–0.919); apical disc 0.154 × 0.225—0.315; segmentation of proglottids not entirely distinct; vitelline cells lobulate; vitellaria discontinuous; ovary slightly bilobed, and post-equatorial; eggs 0.030–0.045 × 0.021–0.024 ..... *S. malayana* sp. nov.

NEMATODA

Six species of spiruroid nematodes belonging to the family Camallanidae were recorded. They belong to the three genera: *Camallanus* Railliet and Henry 1915, *Zeylanema* Yeh 1960, and *Procamallanus* Baylis 1923. The six species we have recorded are *Camallanus yehi* sp. nov., *C. longitridentatus* sp. nov., *Zeylanema anabantis* (Pearse 1933), *Z. pearsei* Yeh 1960, *Procamallanus clarius* Ali 1956, and *P. malaccensis* sp. nov.

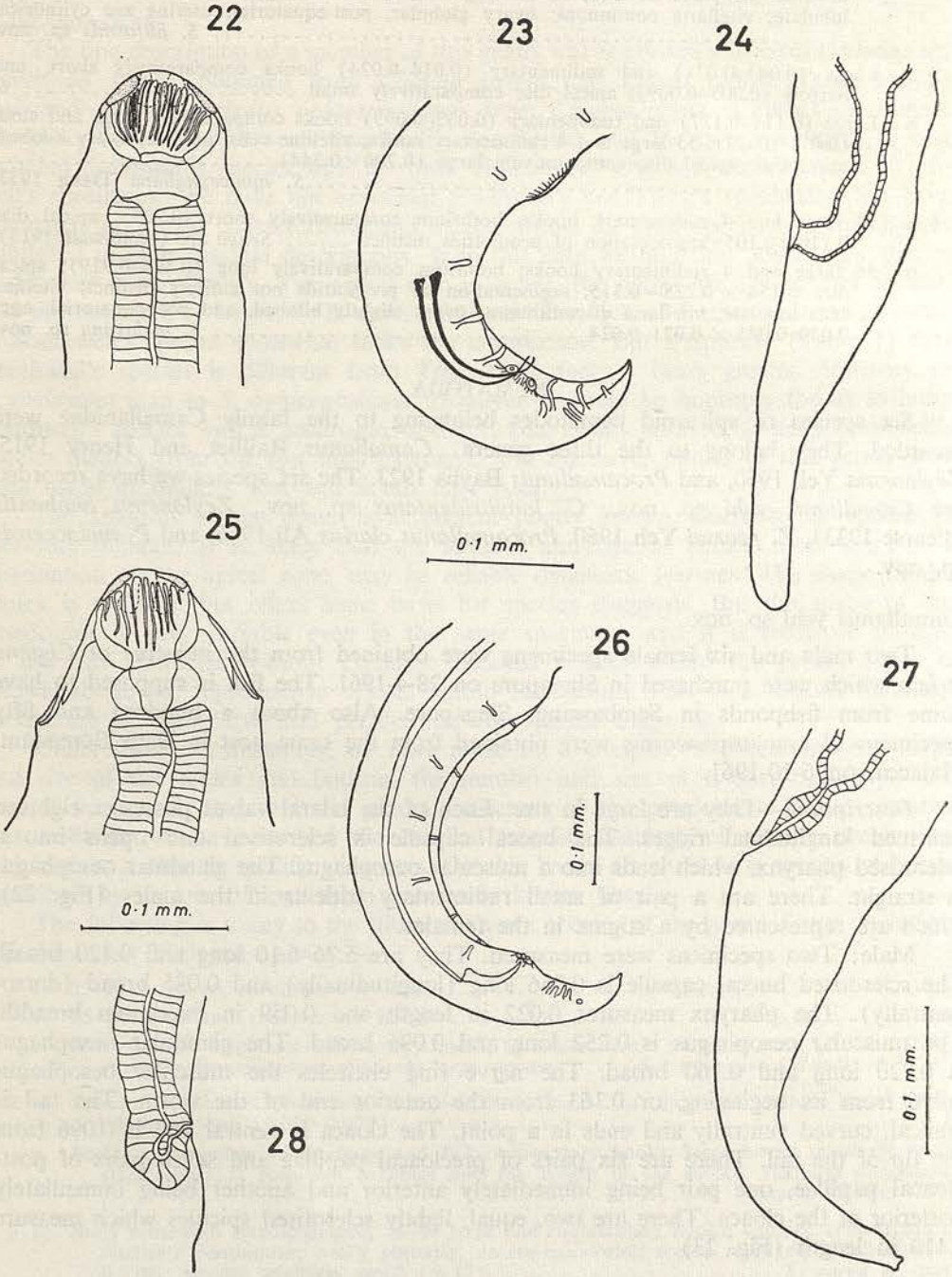
Camallanus yehi sp. nov.

Two male and six female specimens were obtained from the intestine of *Channa striata* which were purchased in Singapore on 28-4-1961. The fish is supposed to have come from fishponds in Sembawang, Singapore. Also about a hundred and fifty specimens of immature worms were obtained from the same host in Batu Berendam, Malacca, on 6-10-1961.

Description.—They are large in size. Each of the lateral valves possesses eighteen unarmed longitudinal ridges. The buccal capsule is sclerotised and opens into a sclerotised pharynx, which leads into a muscular oesophagus. The glandular oesophagus is straight. There are a pair of small rudimentary tridents in the males (Fig. 22), which are represented by a stigma in the females.

Male: Two specimens were measured. They are 5.76–6.10 long and 0.120 broad. The sclerotised buccal capsule is 0.056 long (longitudinally) and 0.085 broad (dorso-ventrally). The pharynx measures 0.022 in length and 0.059 in maximum breadth. The muscular oesophagus is 0.252 long and 0.096 broad. The glandular oesophagus is 0.720 long and 0.160 broad. The nerve ring encircles the muscular oesophagus 0.096 from its beginning, or 0.163 from the anterior end of the worm. The tail is conical, curved ventrally and ends in a point. The cloaca is ventral and is 0.096 from the tip of the tail. There are six pairs of precloacal papillae and seven pairs of post-cloacal papillae, one pair being immediately anterior and another being immediately posterior of the cloaca. There are two, equal, lightly sclerotised spicules which measure 0.110 in length (Fig. 23).

Female: Three specimens were measured. They are 7.2–10.5 long and 0.240 broad. The sclerotised buccal capsule measures 0.056–0.059 in length and 0.074–0.082 in maximum breadth. The sclerotised pharynx is 0.026 long and 0.059 broad. The muscular oesophagus measures 0.320 in length and 0.096 in maximum breadth. The



Figures 22–28. (22–24) *Camallanus yehi* sp. nov. (22) Lateral view of head. (23) Lateral view of male tail. (24) Lateral view of female tail. (25–28) *Camallanus longitridentatus* sp. nov. (25) Lateral view of head. (26) Lateral view of male tail. (27) Lateral view of female tail. (28) Lateral view of vulva.

glandular oesophagus measures 0.640–0.800 in length and 0.112–0.128 in maximum breadth. The nerve ring surrounds the muscular oesophagus 0.085–0.093 from its anterior end, or 0.166–0.185 from the anterior end of the worm. The tail is conical and rounded at its tip (Fig. 24). The anus is 0.240–0.315 from the tip of the tail. The vulva is slightly anterior of the mid-body and divides the worm in the ratio of 1:1.1 — 1:1.5.

Discussion.—These worms resemble the description given by Karve (1941), of the females of *C. ophicephali* Pearse, from *Channa striata* from India, in their size, the measurements of the organs, and in the fact that the females possess the stigma of the tridents. They however differ from Karve's species in the number of longitudinal ridges in the buccal capsule and the apical termination of the tail. They also resemble *C. ophicephali* Pearse (1933), but differ from it in size, the number and position of the papillae, the size of the spicules, the stigma of the tridents in the females, and the number of ridges in the buccal capsule. Thus this species is different from the above two, although it bears certain features in common with each of them. However, since we have not examined Karve's and Pearse's specimens of *C. ophicephali*, we are unable to comment further on their specific relationships.

We have named this species *Camallanus yehi* sp. nov. in honour of Dr. L. S. Yeh, London School of Hygiene and Tropical Medicine, who has contributed outstandingly to the taxonomy of the Camallanidae.

Types.—Deposited in the Department of Zoology, University of Singapore, and the British Museum (Natural History), London.

Camallanus longitridentatus sp. nov.

One male and two female specimens were obtained from the intestine of *Clarias batrachus* on 28-4-1961 and 20-7-1961. These fish were purchased in Singapore, and are supposed to have come from fishponds in Sembawang, Singapore.

Description.—The buccal capsule in both sexes consists of two very heavily sclerotised lateral valves. Each buccal valve possesses nine to ten longitudinal unarmed ridges, the median ones of which extend along the whole length of the valve whilst the outermost ones are short. The buccal capsule leads into a heavily sclerotised pharynx which opens into a muscular oesophagus, which is followed by a glandular oesophagus. There are two pairs of unusually long tridents present in both the sexes; they measure 0.079 (Fig. 25).

Male: One specimen was measured. It is 9.12 long and 0.224 broad. The buccal capsule has a longitudinal length of 0.07 and a dorso-ventral length of 0.07. The pharynx measures 0.034 in length and 0.061 in maximum breadth. The muscular oesophagus has a length of 0.432 and a maximum breadth of 0.115. The glandular oesophagus measures 0.80 in length and 0.108 in maximum breadth. The nerve ring encircles the muscular oesophagus 0.094 from its anterior end, or 0.194 from the anterior end of the worm. The tail is conical, curved ventrally and pointed at the tip. The cloaca is ventral and is 0.115 from the tip of the tail. There are six pairs of precloacal and six pairs of postcloacal papillae, one pair being immediately precloacal and another being immediately postcloacal. There are two spicules of unequal size which measure 0.09 and 0.756 (Fig. 26).

Female: Two specimens were measured. They are 7.2–12.1 long and 0.162–0.234 broad. The buccal capsule has a longitudinal length of 0.061–0.068 and a dorso-ventral length of 0.072. The pharynx measures 0.032–0.036 in length and 0.025 in maximum breadth. The muscular oesophagus has a length of 0.320–0.360 and a maximum breadth of 0.080–0.112. The glandular oesophagus measures 0.900–0.936 in length and 0.032–0.061 in maximum breadth. The nerve ring surrounds the muscular oesophagus 0.061–0.115 from its anterior end, or 0.162–0.216 from the anterior end of the worm. The tail is conical and bifid at the tip (Fig. 27). The anus is 0.216–0.274 from the tip of the tail. The vulva is posterior of the mid-body and divides the worm in the ratio of 1.36 :1—1.42 :1. The vulva is shown in Fig. 28. The specimens contained young larvae.

Discussion.—This species is characterised by the large prominent tridents and the small number of ridges in the buccal valves (9–10). It also has unequal spicules, and six pairs of precloacal and six pairs of postcloacal papillae which are distributed in a characteristic way. These peculiar features make this species different from all the other species of the genus *Camallanus*.

We have named this species *Camallanus longitridentatus* sp. nov. because of the long, prominent tridents.

Types.—Deposited in the Department of Zoology, University of Singapore.

Zeylanema pearsei Yeh 1960.

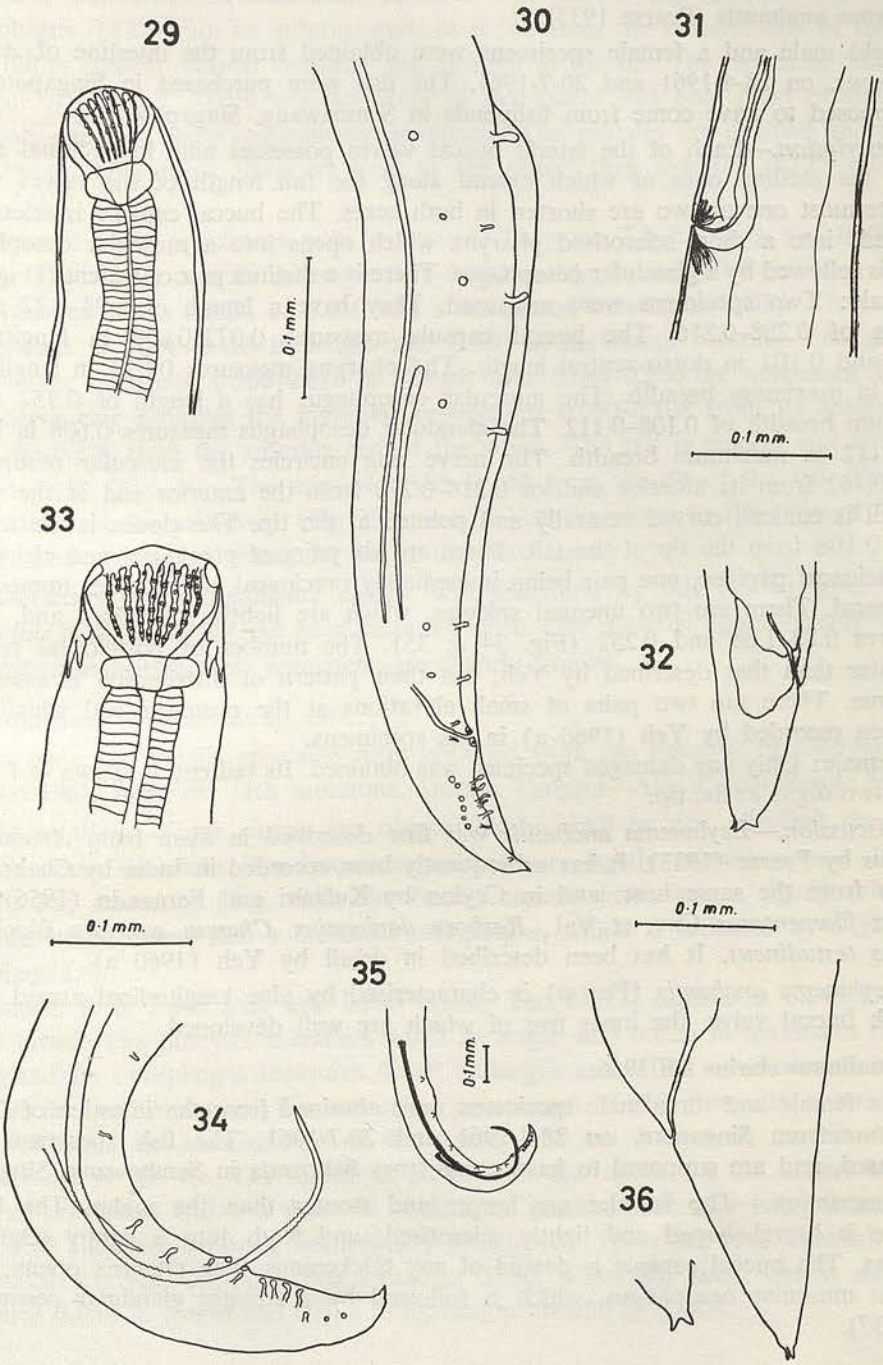
One male and one female specimen were obtained from the intestine of an *Anabas testudineus,* which was purchased in Singapore on 28-4-1961. The fish host is supposed to have come from fishponds in Sembawang, Singapore.

Description.—These worms are comparatively large in size. In both the sexes the buccal valves are sclerotised and each valve possesses seven armed longitudinal ridges (Fig. 29). The buccal capsule leads into a lightly sclerotised pharynx which is followed by a muscular oesophagus, which opens into a glandular oesophagus. There are no tridents in either the male or the female.

Male: The anterior part of the worm was damaged; and only measurements of the posterior part were possible. The tail is conical, curved ventrally and pointed at the tip. It bears a small tubercle near the tip of the tail. The cloaca is 0.100 from the tip of the tail. There are eight pairs of precloacal and eight pairs of postcloacal papillae, one pair being immediately precloacal and another pair being immediately postcloacal. The second pair of precloacal papillae is very small. There are two, unequal, lightly sclerotised spicules. The left spicule measures 0.155 in length and the right one measures 0.880 (Fig. 30).

Female: One specimen was measured. It is 3.680 long and 0.096 broad. The buccal capsule measures 0.063 in longitudinal length and 0.074 in dorso-ventral length. The pharynx has a length of 0.022 and a maximum breadth of 0.056. The muscular oesophagus measures 0.304 in length and 0.080 in maximum breadth. The gandular oesophagus has a length of 0.480 and a maximum breadth of 0.065. The nerve ring encircles the muscular oesophagus 0.130 from its anterior end, or 0.222 from the anterior end of the worm. The tail is conical and terminates at the tip into three digits (Fig. 32). The anus is 0.096 from the tip of the tail. The vulva is slightly posterior of the midbody and divides the body in the ratio of 1 :1.05; it is shown in Fig. 31.

Discussion.—This species was described from two female specimens from Ceylon, taken from *Rasbora daniconius* Ham. Buch., by Yeh (1960 a). He also included in this species the female of Pearse's (1933) *Camallanus anabantis*, because Pearse's description included two distinct species.



Figures 29–36. (29–32) *Zeylanema pearsei* Yeh. (29) Lateral view of head. (30) Latero-ventral view of male tail. (31) Lateral view of vulva. (32) Lateral view of female tail. (33–36) *Zeylanema enabantis* (Pearse). (33) Lateral view of head. (34 and 35) Lateral view of male tail. (36) Lateral view of female tail.

Our material agrees very closely with the description of the female given by Yeh (l.c.). We have described a male of this species for the first time. *Zeylanema pearsei* Yeh is characterised by the absence of tridents and the possession of seven longitudinal armed ridges in each buccal valve.

Zeylanema anabantis (Pearse 1933).

Eight male and a female specimens were obtained from the intestine of *Anabas testudineus,* on 28-4-1961 and 20-7-1961. The fish were purchased in Singapore and are supposed to have come from fishponds in Sembawang, Singapore.

Description.—Each of the lateral buccal valves possesses nine longitudinal armed ridges, the median ones of which extend along the full length of the valves whilst the outermost one or two are shorter, in both sexes. The buccal capsule is sclerotised and leads into a short sclerotised pharynx which opens into a muscular oesophagus, which is followed by a glandular oesophagus. There is a distinct pair of tridents (Fig. 33).

Male: Two specimens were measured. They have a length of 5.94–6.72 and a breadth of 0.208–0.216. The buccal capsule measures 0.072–0.079 in longitudinal length and 0.101 in dorso-ventral length. The pharynx measures 0.021 in length and 0.072 in maximum breadth. The muscular oesophagus has a length of 0.352 and a maximum breadth of 0.108–0.112. The glandular oesophagus measures 0.608 in length and 0.112 in maximum breadth. The nerve ring encircles the muscular oesophagus 0.126–0.162 from its anterior end, or 0.216–0.270 from the anterior end of the worm. The tail is conical, curved ventrally and pointed at the tip. The cloaca is ventral and 0.101–0.108 from the tip of the tail. There are six pairs of precloacal and eight pairs of postcloacal papillae, one pair being immediately precloacal and another immediately postcloacal. There are two unequal spicules, which are lightly sclerotised and, which measures 0.88–1.08 and 0.252 (Fig. 34 & 35). The number of postcloacal papillae is greater than that described by Yeh; but their pattern of distribution is essentially the same. There are two pairs of small elevations at the posterior end which have not been recorded by Yeh (1960 a) in his specimens.

Female: Only one damaged specimen was obtained. Its tail end is shown in Fig. 36. It has two digits at the tip.

Discussion.—Zeylanema anabantis was first described in Siam from *Anabas testudineus* by Pearse (1933). It has subsequently been recorded in India by Chakravarty (1939) from the same host; and in Ceylon by Kulasiri and Fernando (1956) from *Puntius filamentosus* Cuv. et Val., *Rasbora daniconius, Channa punctata* Bloch and *Anabas testudineus*. It has been described in detail by Yeh (1960 a).

Zeylanema anabantis (Pearse) is characterised by nine longitudinal armed ridges in each buccal valve, the inner five of which are well developed.

Procamallanus clarius Ali 1956.

Six female and three male specimens were obtained from the intestine of *Clarias batrachus* from Singapore, on 28-4-1961 and 20-7-1961. The fish specimens were purchased, and are supposed to have come from fishponds in Sembawang, Singapore.

Description.—The females are longer and stouter than the males. The buccal capsule is barrel-shaped and lightly sclerotised, and leads into a lightly sclerotised pharynx. The buccal capsule is devoid of any thickenings. The pharynx opens into a straight muscular oesophagus, which is followed by a straight glandular oesophagus (Fig. 37).

Male: One specimen was measured. It is 4.24 long and 0.096 broad. The buccal capsule measures 0.047 in length and 0.040 in breadth. The pharynx had a length of 0.011 and a maximum breadth of 0.025. The muscular oesophagus measures 0.360 in length and 0.054 in maximum breadth. The glandular oesophagus is 0.576 in length and 0.054 in maximum breadth. The nerve ring encircles the muscular oesophagus 0.126 from its anterior end, or 0.180 from the anterior end of the worm. The tail is conical, curved ventrally and pointed at the tip. The cloaca is 0.047 from the tip of the tail. There are ten pairs of precloacal and four pairs of postcloacal papillae, one pair being immediately precloacal. The spicules are unequal and straight, one being about three times as long as the other; they measure 0.123 and 0.043 (Fig. 38).

Female: Two specimens were measured. They are 5.6–6.1 long and 0.144–0.176 broad. The buccal capsule measures 0.76–0.080 in length and 0.058–0.062 in breadth. The pharynx has a length of 0.010 and a maximum breadth of 0.036. The muscular oesophagus is 0.370–0.400 in length and 0.080 in maximum breadth. The glandular oesophagus measures 0.560–0.610 in length and 0.064–0.080 in maximum breadth. The nerve ring encircles the muscular oesophagus 0.090–0.108 from its anterior end, or 0.180–0.208 from the anterior end of the worm. The tail is conical and terminates in two digits (Fig. 40). The anus is 0.108–0.140 from the tip of the tail. The vulva is posterior of the mid-body (Fig 39), and divides the worm in the ratio of 1.2 : 1—1.4 : 1. They possessed young larvae in the body cavity.

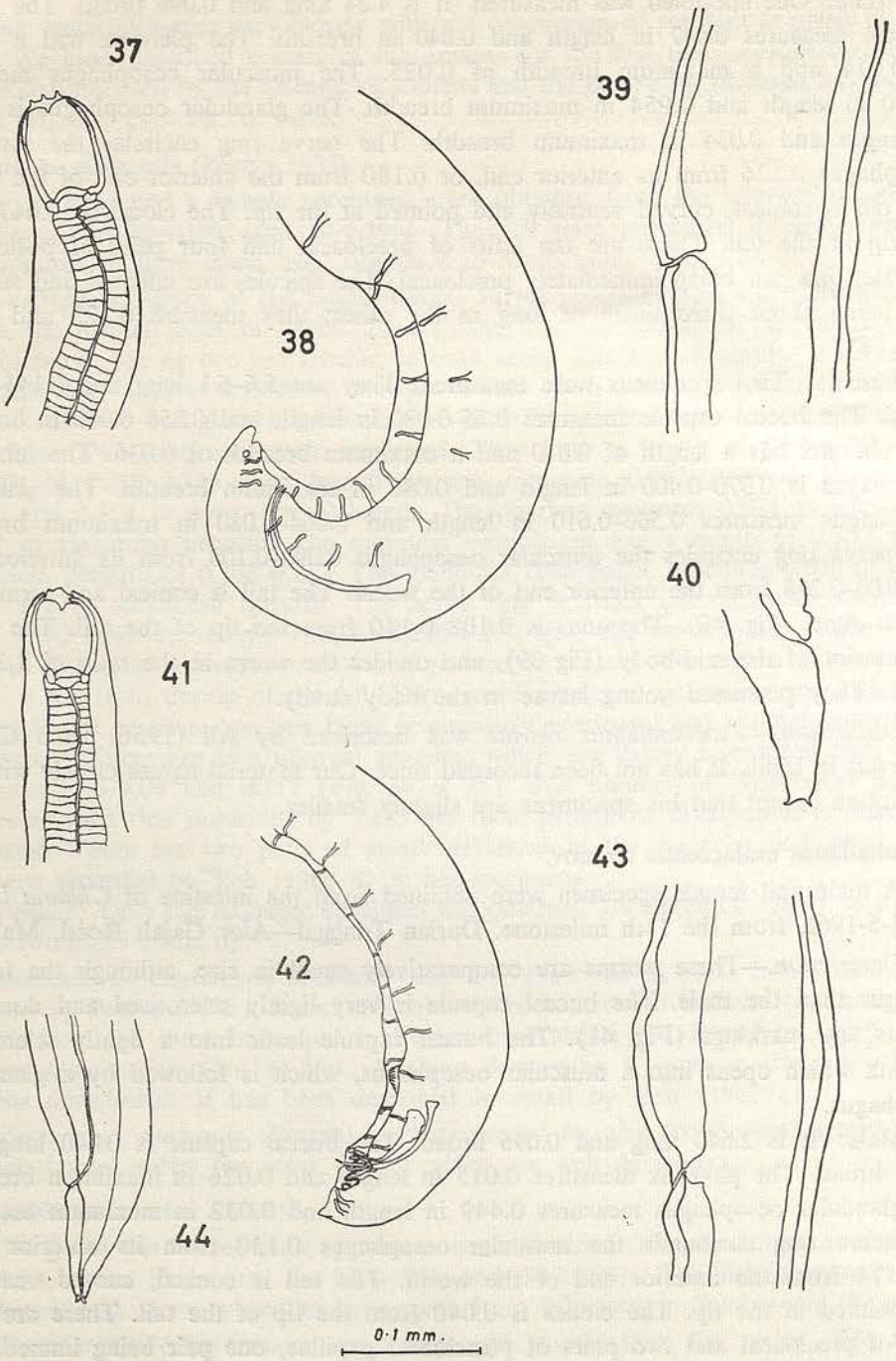
Discussion.—Procamallanus clarius was described by Ali (1956) from *Clarias batraclius* in India. It has not been recorded since. Our material agrees closely with his description except that his specimens are slightly smaller.

Procamallanus malaccensis sp. nov.

A male and female specimen were obtained from the intestine of *Channa lucius*, on 21-5-1961, from the 11th milestone, Durian Tunggal—Alor Gajah Road, Malacca.

Description.—These worms are comparatively small in size, although the female is larger than the male. The buccal capsule is very lightly sclerotised and does not possess any markings (Fig. 41). The buccal capsule leads into a lightly sclerotised pharynx which opens into a muscular oesophagus, which is followed by a glandular oesophagus.

Male: It is 2.640 long and 0.096 broad. The buccal capsule is 0.040 long and 0.033 broad. The pharynx measures 0.015 in length and 0.026 in maximum breadth. The glandular oesophagus measures 0.449 in length and 0.032 in maximum breadth. The nerve ring surrounds the muscular oesophagus 0.130 from its anterior end, or 0.174 from the anterior end of the worm. The tail is conical, curved ventrally and pointed at the tip. The cloaca is 0.040 from the tip of the tail. There are nine pairs of precloacal and two pairs of postcloacal papillae, one pair being immediately precloacal and another being immediately postcloacal. There are two, unequal, lightly sclerotised spicules; the large one measures 0.130, whilst the small one is stout and measures 0.050 in length and 0.075 in maximum breadth (Fig. 42).



Figures 37–44. (37–40) *Procamallanus clarius* Ali. (37) Lateral view of head. (38) Lateral view of male tail. (39) Lateral view of vulva. (40) Lateral view of female tail. (41–44) *Procamallanus malaccensis* sp. nov. (41) Lateral view of head. (42) Lateral view of male tail. (43) Lateral view of vulva. (44) Lateral view of female tail.

Female: It is 4.494 long and 0.150 broad. The buccal capsule has a length of 0.056 and a breadth of 0.045. The pharynx is 0.019 in length and 0.037 in maximum breadth. The muscular oesophagus measures 0.352 in length and 0.048 in maximum breadth. The glandular oesophagus has a length of 0.528 and a maximum breadth of 0.040. The nerve ring encircles the muscular oesophagus 0.133 from its anterior end, or 0.207 from the anterior end of the worm. The tail is conical and it terminates at the tip into three digits (Fig. 44). The anus is 0.089 from the tip of the tail. The vulva (Fig. 43) is slightly posterior of the mid-body and divides the body in the ratio of 1.25 :1.

Discussion.—This species differs from all the *Procamallanus* species so far described in its size, the shape and size of the spicules, and the number and arrangement of the papillae on the caudal alae.

We have named this species *Procamallanus malaccensis* sp. nov. after its type locality, Malacca.

Types.—Deposited in the Department of Zoology, University of Singapore.

General Discussion

The first comprehensive account of the Camallanidae was given by Tornquist (1931). Since then many species have been added to the family especially in South East Asia. Notable among more recent workers on this group are Ali (1956, 1960) and Yeh (1960a, 1960b.).

The life cycle of Camallanids has been studied by Li (1935) and Pereira, Dias and de Azevedo (1936). It has also been discussed in some detail by Kulasiri and Fernando (1956). The first intermediate host is a copepod and the final host may be infected directly. In some cases, small fishes may serve as "carrier hosts" (Kulasiri and Fernando 1956).

ACANTHOCEPHALA

One species of acanthocephalan was found. It belongs to the family Quadrigyridae, and the genus *Pallisentis* van Cleave 1928. The species we have recorded is *Pallisentis gaboes* (MacCallum).

Pallisentis gaboes (MacCallum 1918).

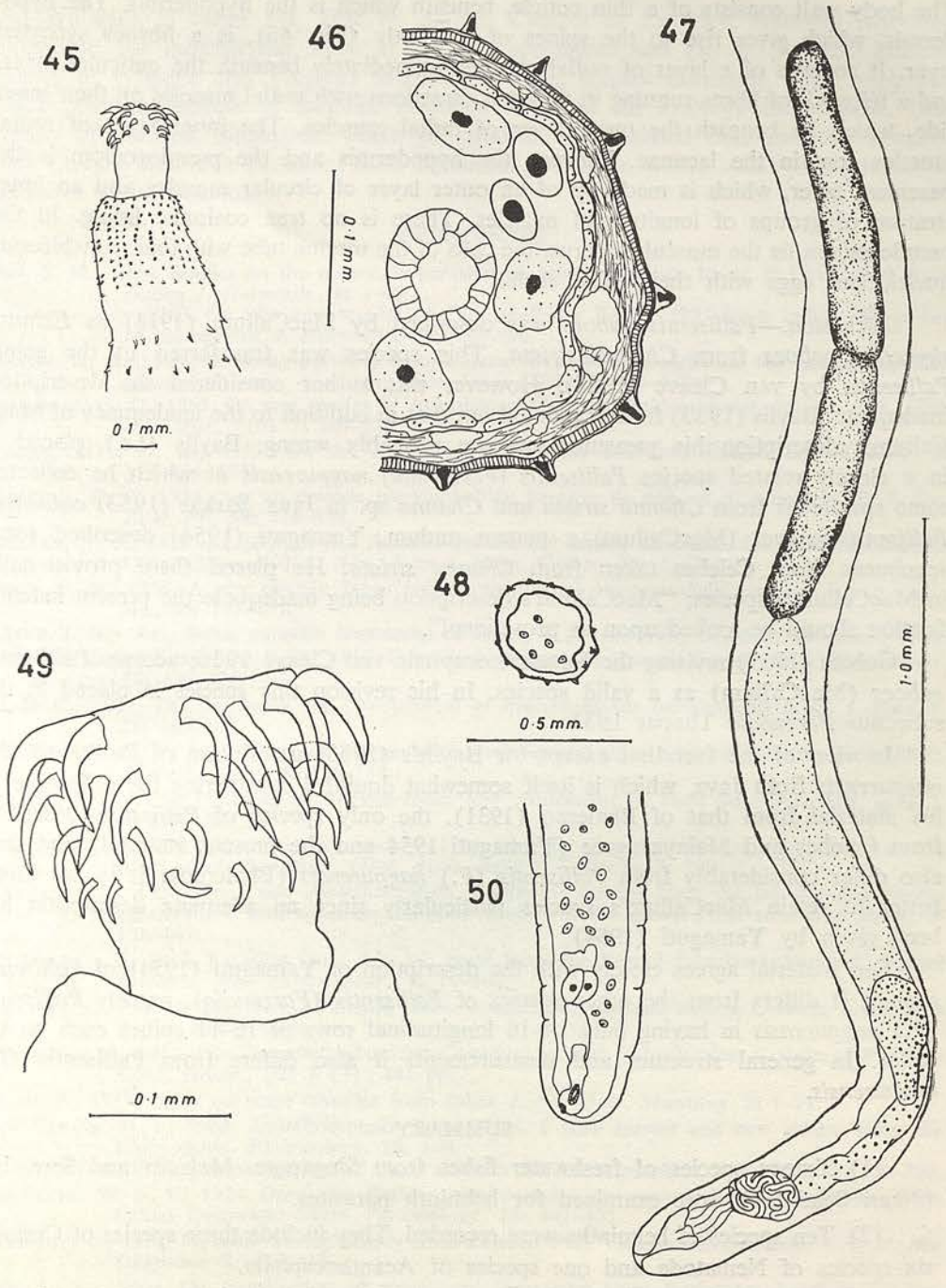
Several mature and immature specimens were obtained from the intestine of *Channa striata* from Malacca, Seremban (Negri Sembilan) and Singapore.

Description.—The body is tubular and slender. The body consists of a proboscis, neck and trunk. The proboscis, in both sexes, is subcylindrical and armed with ten oblique rows of four hooks each (Fig. 49). The anteriomost hooks are most strongly curved posteriorwards and long. The neck is cylindrical and smooth. The trunk is cylindrical and exhibits false segmentation when contracted; its anterior half is armed with spines which are distributed in two regions of different densities. The extent to which the trunk is armed with spines exhibits sexual dimorphism, the armature

being proportionately greater in extent in the females than in the males. The denser area of spines is at the anterior end of the trunk, and is sometimes termed the "collar' (Fig. 45). The male and female genitalia occur in the posterior part of the trunk. The trunk is rounded at its posterior extremity in both sexes.

Male: Two specimens were measured. The body is 8.0–10.8 in length and 0.306–0.450 in maximum breadth. The proboscis measures 0.144 in length and 0.162–0.198 in maximum breadth. The anteriormost hooks of the proboscis measure 0.083–0.090 in length, whilst the posteriormost hooks measure 0.025. The neck is 0.108–0.216 in length and 0.144–0.090 broad. The dense area of spines on the trunk measures 0.240–0.320 in length, and consists of 14–16 longitudinal rows of 10–11 spines each. The less dense area of spines on the trunk is immediately posterior to the dense area and measures 2.7–3.6 in length; it consists of circular rows of ten to twenty spines each, the rows being more than 0.080 apart. The proboscis sheath is conical and 0.480–0.576 long. The lemnisci are narrow and 0.480–0.960 long. The testes are cylindrical to elliptical in shape and measure 0.960–1.360 × 0.176–0.224. There are two testes, the anterior one of which begins just anterior of the mid-body. Behind the testes is situated the cement gland, which measures 0.720–1.600 × 0.208–0.224 and, which is somewhat cylindrical in shape. Situated posterior to the cement gland is the cement reservoir, which is elliptical in shape and measures 0.320–0.400 × 0.144–0.192. The seminal vesicle lies posterior to the cement reservoir; it is elongated and measures 0.640 × 0.096–0.128. Adjacent to the seminal vesicle lies the Saefftigen's pouch (shown as unstippled in the figure) which measures 0.160–0.240 × 0.112–0.128. The bursal cap occurs immediately behind this for 0.320, and is followed by the copulatrix bursa which is about 0.192 in length (Fig. 47).

Female: Three specimens were measured. They are 12.8–22.4 long and 0.400 broad. The proboscis has a length of 0.160 and a breadth of 0.208. The anteriormost hooks of the proboscis measure 0.096 in length, whilst the posteriormost hooks measure 0.032. The neck has a length of 0.240 and a breadth of 0.192. The trunk is 11.2–22.1 long and 0.272–0.400 broad. The dense area of spines occurs at the anterior end of the trunk and measure 0.240–0.480 in length; it possesses 14–16 longitudinal rows of 11–12 spines each. The less dense area is immediately behind the dense area and extends 8.0–15.2 in length; it consists of circular rows of 10–20 spines each, the rows being more than 0.080 apart. The proboscis sheath is conical and measures 0.520–0.640 in length. The leminisci which occur behind the proboscis sheath are narrow and have a length of 1.280–3.200. The genitalia begins about 0.5 from the vaginal opening. The uterine bell, which is funnel-shaped and measures 0.160 in length and 0.128 in maximum breadth, opens into the uterus through a uterine tube which consists of several large cells. The uterine sac has a length of 0.240 and a maximum breadth of 0.096; it is followed by the vagina which measures 0.160 in length and 0.048 in maximum breadth. The mature eggs in the female measure 0.064–0.080 × 0.025–0.048 (Fig. 50).



Figures 45–50. *Pallisentis gaboes* (MacCallum). (45) General view of proboscis and anterior portion of trunk. (46 and 48) T.S. through the uterine region of female. (47) Ventral view of male genitalia. (49) Proboscis and neck. (50) Ventral view of female genitalia.

Figs. 46 & 48 show a transverse section through the uterine region of a female. The body wall consists of a thin cuticle, beneath which is the hypodermis. The hypodermis, which gives rise to the spines of the body (Fig. 46), is a fibrous syncytial layer. It consists of a layer of radial muscles immediately beneath the cuticular layer, and a feltwork of fibres running in different directions with radial muscles on their inner side, which lie beneath the outer layer of radial muscles. The inner layer of radial muscles contain the lacunae. Between the hypodermis and the pseudocoelom is the basement layer, which is made up of an outer layer of circular muscles and an inner stratum of groups of longitudinal muscles. There is no true coelomic lining. In the pseudocoelom lie the muscular uterus, the cells of the uterine tube with their conspicuous nuclei, and eggs with their thick shells.

Discussion.—Pallisentis gaboes was described by MacCallum (1918) as *Echinorhynchus gaboes* from *Channa striata*. This species was transferred to the genus *Pallisentis* by van Cleave (1928). However this author considered the description inadequate. Baylis (1933) further pointed out that in addition to the inadequacy of MacCallum's description his measurements are probably wrong. Baylis (l.c.) placed it in a closely related species *Pallisentis* (*Farzandia*) *nagpurensis* of which he collected some specimens from *Channa striata* and *Channa* sp. in Java. Sarkar (1953) considers *Pallisentis gaboes* (MacCallum) a nomen nudum. Yamaguti (1954) described some specimens from Celebes taken from *Channa striata*. He placed these provisionally in MacCallum's species; "MacCallum's description being inadequate the present indentification should be looked upon as provisional".

Golvan (1959) revising the Eoacanthocephala van Cleave 1936, accepts *Pallisentis gaboes* (MacCallum) as a valid species. In his revision this species is placed in the subgenus *Farzandia* Thapar 1931.

In view of the fact that except for Baylis's (1933) description of *Pallisentis* (*F.*) *nagpurensis* from Java, which is itself somewhat doubtful considering the difference of his material from that of Bhalerao (1931), the only species of *Pallisentis* described from Celebes and Malaya agree (Yamaguti 1954 and the present material) and they also differ considerably from *Pallisentis* (*F.*) *nagpurensis* (Bhalerao). It is, we think, better to retain MacCallum's species particularly since an adequate description has been given by Yamaguti (1954).

Our material agrees closely with the description of Yamaguti (1954) of *Pallisentis gaboes*. It differs from the other species of *Pallisentis* (*Farzandia*), namely *Pallisentis* (*F.*) *nagpurensis* in having only 14–16 longitudinal rows of 10–11 spines each on the collar. In general structure and measurements it also differs from Pallisentis (*F.*) *nagpurensis*.

SUMMARY

(1) Sixteen species of freshwater fishes from Singapore, Malacca and Seremban (Negri Sembilan) were examined for helminth parasites.

(2) Ten species of helminths were recorded. They include three species of Cestoda, six species of Nematoda and one species of Acanthocephala.

(3) Of the ten species, we have named six as new. This indicates that the helminth fauna of Malayan freshwater fishes is very inadequately known at present.

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We wish to thank Mr. Eric R. Alfred, Curator of Zoology, National Museum, Singapore, for indentifying some of the fish specimens and Dr. L. S. Yeh, London School of Hygiene and Tropical Medicine, for his helpful criticisms. This work was made possible because of facilities extended to us at the Zoology Department, University of Malaya, Singapore, where the studies were carried out, and the Tropical Fish Culture Research Institute, Batu Berendam, Malacca, where some of the helminth parasites were collected.

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The Distribution of Aquatic Insects in South East Asia with Special Reference to their Dispersal[1]

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INTRODUCTION

AQUATIC HEMIPTERA and Coleoptera are among the commoner inhabitants of freshwaters. They constitute a considerable portion of the fauna numerically. Many species are a valuable source of food for aquatic animals including fishes. Some of the larger species are predators of mosquito larvae and recently suspicion has been cast on them as reservoirs of viruses (personal communication by Dr. C. B. Worth, Rockerfeller Foundation). Although relatively little is known of their ecology and distribution in South East Asia, their importance in the economy of freshwaters is well recognised. The present paper gives a preliminary account of their distribution in South East Asia with special reference to their dispersal. I have omitted from this account the semi-aquatic forms which live on the shore, e.g., Saldidae and Gelastocoridae, and some rare and little known groups of aquatic Coleoptera, e.g., Helodidae.

The distribution of aquatic Hemiptera has been dealt with on a worldwide basis by Hungerford (1956). The only paper which deals comprehensively with the aquatic Hemiptera of South East Asia is that of Lundblad (1933). Whilst these two papers taken together give a general picture of the distribution, the data on which they have been compiled is necessarily meagre due to lack of records from this area. In the case of Malaya, many genera have gone unreported, e.g., *Agraptocorixa, Tropocorixa, Plea* and *Laccocoris*. Recent revisions of genera and groups present in South East Asia have proved very useful in working out the fauna, besides providing data themselves. The most important papers in this connection are Hutchinson (1940), Brooks (1951), Hungerford and Matsuda (1958, 1960) and Chen (1960). Mendis and Fernando (1962) have compiled a list of Ceylonese species adding many records. The author has added many new records for Malaya, Anon (1960), Fernando (1961b, 1963). In the Coleoptera, unfortunately, little is available regarding their distribution except the compilations of Ahlwarth (1910), Knisch (1924) and Zimmerman (1920). A few records have been added by Fernando (1961b, 1961c, 1963). Also records have been added from the author's collections made in Ceylon and Malaya.

COMPOSITION OF THE FAUNA

A comparision of species numbers of South East Asia with Europe gives valuable information as to differences and similarities of the fauna of a temperate region and a tropical region. I have chosen Europe instead of North America because of the generic similarities of the fauna of Europe and South East Asia. The African fauna, though less well known, resembles the South East Asian fauna in generic composition whilst the fauna of South America resembles that of North America.

[1] Presented at the Tenth Pacific Science Congress, Honolulu, Hawaii, 1961.

For the Hemiptera-Heteroptera I have chosen Sweden, Germany and Britain on the one hand and Indonesia, Malaya and Ceylon on the other. The data from which this list (Table 1) has been compiled is that of Lundblad (1933), Macan (1956), Hutchinson (1940), Hungerford and Matsuda (1958, 1960), Fernando (1961b, 1961c, 1963) and Mendis and Fernando (1962).

TABLE 1

Total number of species of Aquatic Hemiptera-Heteroptera of Temperate (Palæarctic) and Tropical (Oriental–S.E. Asia) regions

	Nepidæ	Ranatridæ	Belostomatidæ	Naucoridæ	Corixinæ	Micronectinæ	Helotrephidæ	Pleiidæ	Anisopinæ	Notonectinæ	Mesoveliidæ	Veliidæ	Gerridæ	Hebridæ	Hydrometridæ	Total
Sweden ..	1	1	0	2	27	1	0	0	0	4	1	2	8	2	2	51
Germany ..	1	1	0	2	24	2	0	1	0	4	1	3	10	2	2	53
Britain ..	1	1	0	1	27	3	0	1	0	5	1	8	10	2	2	62
Indonesia ..	6	5	3	7	3	14	4	3	7	8	3	17	22	6	4	112
Ceylon ..	4	6	2	3	2	10	1	2	8	6	1	4	16	2	1	67
Malaya ..	4	4	3	2	2	8	1	2	8	4	2	1	18	1	4	64

Table 1 shows the species numbers of the various families as far as it is known today. South East Asia is rich in belostomatids and nepids. The former are absent from temperate Europe and the latter poorly represented in that region. Both these families are represented today mainly by non-flying forms. The Corixidae which form the dominant group in Europe are relatively poorly represented in South East Asia as far as species are concerned. This family is represented in Europe mainly by the larger *Corixa* (including the "genera" or "sub genera" *Glaenocorixa, Callicorixa,* etc.) and *Sigara.* In South East Asia the dominant genus is *Micronecta.* Even this genus is represented by few species. Fernando (1961b) suggests that the small numbers of species of *Micronecta* in South East Asia is probably due to the mobility of some species like *Micronecta quadristrigata* Breddin which is also eurytopic and displaces local species, which are not so mobile.

The Notonectidae are represented in Europe mainly by the genus *Notonecta.* This family is far better represented in South East Asia by *Anisops* (Anisopinae) and *Enithares* (Notonectinae) which are very widespread and have a large number of species. Another genus *Nychia* (Notonectidae) with relatively few species also occurs in this region.

The Naucoridae, Mesoveliidae, Hebridae and Hydrometridae have somewhat more representatives in South East Asia than in Europe and the Gerridae are more varied in genera and more numerous in species in South East Asia. The family Helotrephidae are South East Asian and American in distribution and the Pleiidae occur both in Europe and South East Asia.

It can be said in general that except for the Corixidae, South East Asia is rich in species of aquatic Hemiptera-Heteroptera as compared with temperate Europe, especially since the fauna of the former region is less well known. The former region also has greater variety of genera.

For the aquatic Coleoptera, Britain, Ceylon and Malaya have been chosen for comparison of species numbers (Table 2). The data for this was obtained from Balfour-Browne (1953, 1958), Ahlwarth (1910), Knisch (1924), Zimmerman (1920), Fernando (1961b, 1961c) and Mendis and Fernando (1962).

TABLE 2

Total number of species of Aquatic Coleoptera of Britain (Temperate-Palæartic) and Malaya and Ceylon (Tropical-Oriental, S.E. Asia)

	Hydrophilidæ	Noteridæ	Hygrobiidæ	Dytiscidæ	Haliplidæ	Gyrinidæ	Total
Britain	79	2	1	104	16	11	213
Ceylon	61	4	0	44	2	16	127
Malaya ..	37	7	0	23	1	18	86

In total number of species it appears that the South East Asian region falls short of the European region. It is however true that relatively little is known of aquatic Coleoptera in South East Asia.

The Hydrophilidae and Dytiscidae are more numerous in Britain as compared to Ceylon and the fauna of Malaya appears even poorer, but this is largely due to the fauna of Britain and Ceylon being better known. The Noteridae on the other hand are more numerous in species in both Malaya and Ceylon. In Malaya the Noteridae are extremely common and perhaps occupy some of the niches usually occupied by the smaller Dytiscidae. Also the Gyrinidae are extremely numerous especially in Malaya. The Haliplidae are poorly represented in Malaya and Ceylon whilst the Hygrobiidae are entirely absent.

The Hydrophilidae are represented in South East Asia by a few cosmopolitan genera like *Hydrophilus*. Many genera are common to the Oriental, and Ethiopian regions, e.g., *Amphiops*. *Globaria* and *Regimbartia* extend northwards as far as Japan in addition. *Sternolophus* is found in the Oriental, Ethiopian and Australasian regions.

The largest Dytiscids in South East Asia belong to the genus *Cybister*. *Hydrovatus* is a widespread and common genus, and *Sandracottus* is a South East Asian genus.

The Noteridae are represented mainly by the genera *Canthydrus* and *Hydrocoptus*.

The Gyrinidae include a number of genera. *Orectocheilus* is the most prolific in species.

Since our knowledge of the South East Asian Coleoptera is meagre, no definite conclusions can be drawn, yet it has been shown that many species are mobile in South East Asia as compared with Europe and it is likely that local speciation has been restricted for this reason.

DISTRIBUTION

If we consider the distribution of individual species and correlate this with their ability to fly we get some very interesting results. Information of flight has been obtained from studies of colonization of isolated habitats and catches at light (Fernando 1959, 1960, 1961b, 1961c, 1963).

Many of the South East Asian species have relatively small ranges from what is known at present. A few have a very wide range extending from China and Japan in the North to New Guinea in the South and the Eastern and Western limits being the Philippines, Borneo, Celebes, Indonesia and India and Ceylon.

To this group of widely distributed species belong nine species of Hemiptera-Heteroptera namely *Laccotrephes robustus* Stal., *Lethocerus indicus* (Lep. et Serv.), *Sphaerodema rusticum* L., *Micronecta quadristrigata* Breddin, *M. scutellaris* Stal., *Anisops nasuta* (Fieb.)[2], *Limnogonus fossarum* (F.), *Mesovelia orientalis* Kirk. and *Microvelia douglasi* Kirk. Their distribution is given below:—

Laccotrephes robustus	India, Sumatra, Java, Malaya, Bali, Borneo, Formosa, Philippines and Celebes.
Lethocerus indicus	Ceylon, India, China, Japan, Java, Sumatra, Malaya, Siam, Formosa and Philippines.
Sphaerodema rusticum	Ceylon, India, China, Japan, Formosa, Malaya, Siam, Sumatra, Java, Bali, Philippines and New Guinea.
Micronecta quadristrigata	Ceylon, India, Malaya, Sumatra, Java and Philippines.
Micronecta scutellaris	Ceylon, India, Burma, Malaya, Sumatra, Java, China and Africa.
Anisops nasuta	India, China, Malaya, Sumatra, Java, Formosa, Celebes and New Guinea.
Limnogonus fossarum	Ceylon, India, China, Formosa, Sumatra, Java, Malaya, Philippines and Celebes.
Mesovelia orientalis	Ceylon, India, Formosa, Malaya, Sumatra, Java, Bali, Lombak, Philippines and New Guinea.
Microvelia douglasi	Ceylon, India, Japan, Malaya, Sumatra, Java and Samoa.

All these species have been taken at artificial lights and also been recorded in isolated habitats except *Laccotrephes robustus* and *Sphaerodema rusticum* (Table 3).

In the case of *Laccotrephes robustus* and *Sphaerodema rusticum,* these seem to have lost their ability to fly recently. In the Nepidae and the Belostomatidae to which these species belong selection against flight appears to be taking place. This view is supported by the fact that two less widely distributed species namely *Laccotrephes simulatus* Mont. and *Sphaerodema molestum* (Duf.) have been recorded at light and in isolated habitats in Malaya. Also the belostomatid *Lethocerus indicus* is a good flier and the belostomatids in general are good fliers in Africa and South America.

[2] Many records of this species probably refer to *Anisops batillifrons* Lundb. which is very widely distributed. *A. nasuta* is also very widespread, and both these species have been recorded at light.

The next most widely distributed group consists of *Laccotrephes grossus* (F.), *Limnogonus pervulus* (Stal.), *Plea liturata* (Fieb.), *Agraptocorixa hyalinnipennis* (F.) *Anisops batillifrons* Lundb., *A. bouvieri* Kirk and *Rhagodotarsus kraeplini* Breddin (Lundblad 1933, Brooks 1951). Of these *Plea liturata, Anisops batillifrons* and *A. bouvieri* have been taken at light and are also found in isolated habitats (Fernando 1959, 1961b). *Rhagodotarsus kraeplini* has been recorded in isolated habitats (Fernando 1963).

These two groups of widely distributed species therefore accounts for nine of the 19 species recorded at light in South East Asia (Table 3) of a total of over 200 species. It is therefore very likely that the ability to fly is closely correlated with wide distribution. It is worth noting also that of the 19 species recorded at light, 11 belong to the Corixidae and Notonectidae. The members of these two families are the commonest in isolated habitats all over South East Asia.

TABLE 3

The "mobility" of aquatic Hemiptera-Heteroptera of S.E. Asia. —=present, 0=absent, X=recorded at light

Most widely distributed species in S.E. Asia	Records at light L and total number of species in the family TF						Total number of species of the family recorded at light in S.E. Asia
	Malaya		Ceylon		Other S.E. Asian countries		
	L	TF	L	TF	L	TF	
Laccotrephes robustus ..	—	8	—	10	—	30	1
Sphærodema rusticum ..	—	3	—	2	—	3	2
Lethocerus indicus ..	X		X		X		
Micronecta scutellaris ..	X	5	X	6	—	30	5
M. quadristrigata ..	X		X		X		
Anisops nasuta ..	X	12	0	14	—	40	6
Limnogonus fossarum ..	X	18	0	16	X	60	2
Microvelia douglasi ..	X	?3	0	4	—	18	2
Mesovelia orientalis ..	X	1	X	1	—	2	1
Total number of species of Aquatic (Hemiptera-Heteroptera) ..	15	61	10	61	?5	200	19

In the Coleoptera the most widely distributed species are *Cybister tripunctatus* Ol., *Hydraticus fabriciii* MacL., *H. vittatus* F. and *Eretes sticticus* L. (Dytiscidae), *Helochares anchoralis* Sharp, *H. pallens* MacL. and *Enochrus esuriens* (Walk.) (Hydrophilidae)

(Zimmerman 1920, Knisch 1924, Fernando 1961b). All these species have been taken at light (Table 4) and have been recorded in isolated habitats Fernando (1959, 1961b, 1961c, 1963). It seems very likely that flight is associated with wide distribution among the Coleoptera. The total number of species at light include 20 dytiscids, 3 noterids, 1 haliplid and 28 hydrophilids. This is a very large number when compared with the number of species recorded at light in Europe. The only record of similar magnitude is that Yamamoto (1951) who recorded 14 dytiscids, 3 haliplids, 3 gyrinids and 21 hydrophilids in Japan.

TABLE 4

The commonest Dytiscidæ and Hydrophilidæ in South East Asia and their occurrence at light. —=present, 0=absent, X=recorded at light

Most widely distributed species in S.E. Asia	Malaya	Ceylon	Other S.E. Asian countries	Total number of species taken at light
Dytiscidæ				20
Cybister tripunctatus ..	X	0	X	
Hydraticus fabricii ..	X	X	—	
H. vittatus	X	—	—	
Eretes sticticus ..	—	X	—	
Hydrophilidæ				28
Helochares anchoralis ..	X	X	—	
H. abnormalis ..	X	—	—	
Enochrus esuriens ..	X	X	—	

In general it can be said that there is a wide variety of aquatic insects flying in South East Asia as compared with Europe. All the previous records of aquatic insects at light have been summarised by Fernando (1961b, 1961c). In Ceylon during two years, 10 species of Hemiptera and 21 species of Coleoptera were taken in chance catches (Fernando 1961c). In Northern Malaya, 10 species of Hemiptera and 23 species of Coleoptera were taken in a light-trap on two successive nights.

DISPERSAL

The dispersal of aquatic insects by flight has been recorded from captures at artificial lights and also from their colonization of isolated habitats. Dispersal can be considered under two headings namely the types of dispersal and the means of dispersal.

TYPES OF DISPERSAL

From a series of studies of colonization of isolated habitats it appears that in South East Asia the main bulk of aquatic insect dispersal is seasonal and associated with rain (Fernando 1959, 1960, 1961b, 1961c, 1963). The association of dispersal with rain is an obvious adaptive feature. Occasional dispersal due to the drying up of habitats also probably takes place although we have no records for this region. The latter type of dispersal is perhaps of little importance whilst the former is part of the colonization cycle (Fernando 1960).

MEANS OF DISPERSAL

The largest species like *Lethocerus indicus* and *Cybister tripunctatus* are powerful fliers capable of flying long distances. Species of smaller sizes like *Hydraticus fabricii* and *Anisops nasuta* probably use both active flight and passive carriage by winds. The smallest species like *Mesovelia orientalis, Microvelia douglasi* and *Micronecta quadristrigata* are probably carried by wind currents although they are capable of flying short distances. Since flight is seasonal and usually associated with rains in South East Asia and rains are often accompanied by winds of high speed, dispersal occurs over long distances under conditions favourable for colonization. The problem of wind dispersal has been discussed by Zimmerman (1948), Gressit (1954), Gressit and Yoshimoto (1961) and Fernando (1961b).

Human agencies may also be responsible for dispersal of species like *Microvelia* (Laird 1956) and other species may also be carried with fresh vegetables (Fernando 1961b).

SUMMARY

A review of the distribution of aquatic Hemiptera and Coleoptera of South East Asia shows that it differs considerably in the number of species in the different families when compared with Europe, the region which it resembles in faunal composition in general.

The most noteworthy features are the small number of Corixidae and Haliplidae and the abundance of Nepidae, Gerridae, Noteridae and Gyrinidae in South East Asia.

The most widely distributed species both of Hemiptera-Heteroptera and Coleoptera have been recorded flying and constitute a high proportion of those recorded. It appears very likely that flight is correlated with wide distribution.

Dispersal is usually seasonal and associated with rains. The means of dispersal varies with the size of the insects. The larger forms use active flight whilst the smaller ones use passive carriage by winds to a greater or lesser extent. The association with rain and winds is an adaptive feature for successful colonization.

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Notes on aquatic insects colonizing an isolated pond in Mawai, Johore

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INTRODUCTION

Many species of aquatic Coleoptera and Hemiptera are able to fly and thus colonize isolated habitats. Many records exist in taxonomic works where these insects have been collected from isolated habitats. Specific mention of colonization are however relatively few and confined almost entirely to Europe and North America. These latter have been summarised by Fernando (1958, 1959a). In South East Asia and the Pacific region some mention has been made of the presence of aquatic Coleoptera and Hemiptera is small habitats by Laird (1956) in connection with studies on mosquito ecology and Lundblad (1933) who gives ecological notes on the species collected by the German Sunda Island Expedition. Fernando (1959b) made some observations on species in isolated habitats in Ceylon.

The present study is based on observations made during the course of about a year of the aquatic Coleoptera and Hemiptera colonizing an isolated pond in a densely forested area of Johore State. Records were kept of the species found, the presence of immature stages and the species inhabiting the surrounding aquatic habitats. In the light of information available as to the other animals in the pond and the food available, the ecology of the various species is discussed.

Twenty species of aquatic Hemiptera—Heteroptera and nine species of Coleoptera were recorded. The most common species belong to three families, the Gerridae and Notonectidae (Hemiptera) and the Gyrinidae (Coleoptera). All these feed on dead and dying animals drowning in the water. There were no small Crustacea and in general the fauna was poor both in number and species as compared with similar ponds in other parts of South East Asia. It appears that besides being isolated from other water bodies the pond was also isolated by the dense forest from receiving wind dispersed animals except those which fly, like some species of aquatic Coleoptera and Hemiptera.

The absence of mosquito larvae in this habitat is interesting. This was probably due to the presence of large numbers of Notonectidae which are voracious feeders on mosquito larvae. The lack of aquatic vegetation would increase predation.

Some evidence is available as regards the breeding periods of the various species of aquatic insects. A strict seasonality does not seem to exist and this is to be expected where no really well marked dry and wet seasons occur.

DESCRIPTION OF HABITAT

Sometime during the middle of 1959 a new road was constructed between Mawai and Sedili which is on the eastern coast of Johore. Due to the filling up of low-lying regions a large number of ponds were formed by the roadside. The pond where the

present study was made is situated roughly halfway between Mawai and Sedili. The distance between Mawai and Sedili being 12 miles, the pond is about six miles from either end. The pond itself is flanked on one side by the road and on the other by high forest (Plate 1: *Above*). Immediately bordering the pond on the forested edge are smaller bushes and grasses. Some of the grasses have invaded the pond or more correctly, when the pond is full it invades the edge of the forest and the grasses there find the moisture a suitable incentive for expansion (Plate 1: *Below*). The area surrounding the pond is relatively open for a dense forest region. This is due to the road building activities having extended beyond the confines of the road itself on either side.

The maximum size reached by the pond was 75 ft. by 150 ft. The central region had a depth of about 3 ft. and there was a gradual slope from the water's edge to the central region. The bottom was covered with a thick layer of laterite wash from the surrounding earth cuttings. The water was alkaline (pH 7.2–7.4). The alkaline nature of this habitat is in marked contrast to the acid condition of the surrounding "old" forest ponds and streams where the water is blackish and has a pH of about 4–5.

Near the forested edge of the pond there was an accumulation of plant debris partly washed down from the forest and partly of the dead leaves of the grasses within the water area. Most of the animals were found living among the grasses and in the shady areas provided by the forest edge.

METHODS

The observations and collections of fauna were carried out at approximately monthly intervals during 1960 except in March when two collections were made. An additional collection was made in April 1961.

The fauna was collected by using fine-meshed nets and the time spent on each occasion was about one hour. When many specimens were available of a single species, care was taken not to remove the majority but when one or two specimens only were available they were brought back for subsequent indentification. Most of the collecting was done near the forested edge among the grasses. The surface living forms were also collected from the other parts of the pond.

COMPOSITION OF THE FAUNA

The aquatic Hemiptera and Coleoptera collected are given in Table 1. The Hemiptera belong to the following families: Veliidae, Mesoveliidae, Hydrometridae, Gerridae, Nepidae, Belostomatidae, Naucoridae, Corixidae, Notonectidae and Pleiidae. This represents all the families of aquatic Hemiptera found in Malaya except the Helotrephidae of which only one species is known to occur in Malaya. In the Coleoptera too, all the families except the Noteridae are represented namely the Hydrophilidae, Dytiscidae and Gyrinidae. In all, 20 species of Hemiptera and 9 species of Coleoptera were recorded.

TABLE 1

Aquatic Insects taken in a pond near Mawai, Johore, —=absent, x=adult, n=nymph, l=larva

Species	Date	27-1-60	18-2-60	2-3-60	13-3-60	17-4-60	3-5-60	19-6-60	17-7-60	21-8-60	18-9-60	20-10-60	10-11-60	28-12-60	29-4-61
Veliidae															
Microvelia douglasi		x	xn	—	—	—	—	—	—	—	—	—	—	—	—
Mesoveliidae															
Mesovelia orientalis		x	xn	x	x	—	—	—	—	—	—	x	—	x	—
Hydrometridae															
Hydrometra maidli		—	—	—	—	—	—	—	—	—	—	x	—	—	x
Gerridae															
Limnogonus fossarum		x	x	xn	x	xn	x	x	x	x	x	x	x	x	xn
L. nitidus		x	x	x	x	—	xn	x	—	xn	x	x	x	—	xn
Rhagodotarsus kraepelini ..		xn	x	xn	x	x	xn	x	x	x	x	x	x	x	x
Nepidae															
Laccotrephes simulatus		x	x	x	xn	x	xn	xn	n	x	xn	—	—	x	—
L. maculatus		—	—	x	—	—	x	x	—	—	—	—	—	—	—
Ranatra varipes		n	—	x	xn	n	—	—	n	—	—	n	—	—	xn
Belostomatidae															
Sphaerodema molestum		—	—	—	—	—	—	—	—	x	—	—	—	—	—
Naucoridae															
Ctenipocoris asiaticus		x	—	n	—	—	n	n	—	n	—	x	—	—	x
Corixidae															
Micronecta scutellaris		—	—	—	—	—	—	—	—	x	—	x	x	x	—
Notonectidae															
Anisops occipitalis		xn	xn	xn	x	x	x	x	x	x	x	xn	x	xn	xn
A. tahitiensis		—	—	—	—	—	—	—	—	—	—	—	x	—	x
A. exigera		—	—	—	—	x	—	—	—	—	—	—	x	—	—
A. breddini		—	—	—	—	—	—	—	—	—	—	x	—	—	—
Anisops nivea		—	—	—	—	x	—	—	—	—	—	x	x	—	—
Enithares mandalayensis ..		x	x	x	x	x	x	x	xn	xn	xn	xn	x	xn	xn
Nychia malayana		x	—	xn	—	—	—	—	—	—	—	—	—	—	—
Pleiidae															
Plea liturata		x	—	—	—	—	—	—	—	—	—	—	—	—	—
Hydrophilidae															
Helochares pallens		x	—	—	—	—	—	—	—	—	—	—	—	—	—
Helochares sp.		—	—	—	—	—	—	—	—	—	—	x	—	—	—
Amphiops pedestris		—	—	x	—	—	—	—	—	—	—	—	—	—	—
Dytiscidae															
Cybister tripunctatus		—	—	xl	x	—	—	—	—	—	—	xl	—	—	—
C. sugillatus		—	—	—	—	x	—	—	—	—	—	—	—	—	—
Hydraticus vittatus		—	—	xl	x	x	x	x	x	x	x	—	x	—	x
Laccophilus rufulus		x	—	x	—	x	—	—	x	x	xl	—	x	—	x
Guignotus inconstans		—	—	x	—	—	—	—	—	—	—	—	x	—	—
Gyrinidae															
Orectocheilus productus		x	x	x	x	x	x	x	x	x	x	x	x	x	x

VELIIDAE

A single species, *Microvelia douglasi* Scott was recorded in January and February. On these two occasions very large numbers were present especially at the forested edge of the pond. In February nymphs were present in considerable numbers. After February this species was not recorded at all. This sudden fall in numbers was probably due to their being preyed upon by the larger Gerridae which had increased considerably in numbers by March. It is also possible that they flew off into new habitats. A combination of these two factor's seems the most probable cause.

Microvelia douglasi is the most widely distributed veliid in South East Asia (Fernando 1961). In Malaya it is extremely common in buffalo wallows in paddy fields and small pools, even ephermeral ones.

MESOVELIIDAE

One species, *Mesovelia orientalis* Kirk was recorded in January, February and March. During this period it was abundant occuring together with *Microvelia douglasi*. A few specimens were found in October and December. It is possible that this species colonizes habitats during October—December. In 1959 the colonizers were able to increase in numbers but in March 1960 the larger surface living forms probably reduced their numbers greatly. It is also likely that in March they flew off to other habitats.

Mesovelia orientalis is the most widely distributed mesoveliid in South East Asia (Fernando 1961). It is a good flier but is probably transported over long distances by wind. It has been recorded at light by Fernando (1961).

Microvelia douglasi and *Mesovelia orientalis* live on the surface and feed largely on dead and drowning insects. *Microvelia* is also reported to feed on mosquito larvae by Frick (1949) and Laird (1956).

HYDROMETRIDAE

A few specimens of *Hydrometra maidli* Hungerford and Evans were taken. Two were captured in October 1960 and six in April 1961. They were found in the shady area close to the forested edge of the pond.

Hydrometra spp. commonly occur in isolated ponds in Malaya. I have collected *Hydrometra maidli* in small ephermeral pools in Kahang, Johore. *Hydrometra greeni* Kirk. has been recorded at light in Ceylon by Fernando (1962).

The hydrometrids are delicate insects living among the vegetation at the edge of ponds. They feed on dead and drowning insects and also on mosquito larvae and small crustacea (Sprague 1956).

GERRIDAE

These were easily the most numerous and occured in large numbers throughout the period of the observations. Three species, *Limnogonus fossarum* (F.), *L. nitidus* (Mayr) and *Rhagodotarsus kraepelini* Bredd. were recorded. The most numerous was *Limnogonus fossarum* followed by *Rhagodotarsus kraepelini*. These two species were collected on all occasions when the pond was visited. *Limnogonus nitidus* was less common and did not occur in the collections made in April, July and December 1960.

All these three species are extremely common in small ponds in Malaya. They often occur in isolated and ephermeral pools. *Limnogonus fossarum* and *L. nitidus* have been recorded at light by Fernando (1961) in Malaya and *L. nitidus* in Ceylon (Fernando 1962). Lundblad (1933) states that *Limnogonus fossarum* comes to artificial lights.

Rhagodotarsus kraepelini is according to Easki (1925), found in ponds and never in flowing water. In Malaya this species is extremely common in fairly large ponds.

Only the gerrids ranged throughout the pond. They are however commoner near the forested edge.

They are surface feeders and live on dead and drowning insects. This source of food seems to have been abundant judging from their numbers. Further they were not restricted in their feeding to the shady areas of the pond like most of the other species.

Nymphs were found in March, April and May 1960 and again in April 1961. Nymphs of all three species occured abundantly in May. It appears likely that breeding took place mainly during the period March—May. *Limnogonus fossarum* was found mating in May. Some nymphs of *Limnogonus nitidus* were also found in October and those of *Rhagodotarsus kraepelini* in January. The evidence available does not permit any definite conclusions as regards the breeding period although it seems likely that most of it occurs from March—May.

NEPIDAE

Three species namely *Laccotrephes simulatus* Mont., *L. maculatus* (F.) and *Ranatra varipes* Mont. were recorded. These species did not occur in large numbers. *Laccotrephes simulatus* was the commonest whilst *Ranatra varipes* and *L. maculatus* were much less common.

The Nepidae as a rule are poor fliers and do not occur in isolated habitats elsewhere. In Malaya however, *Laccotrephes simulatus* has been recorded at light (Fernando 1961). This species is a common inhabitant of forest ponds and has been recorded in isolated habitats in other parts of Johore.

The nepids were all found among the grasses at the forested edge. They are carnivorous species and probably fed on the meagre supply of small animals sheltering among the grasses.

Nymphs of *Laccotrephes simulatus* and *Ranatra varipes* were found but showed no definite periodicity. In the case of these insects the nymphs probably take a relatively long time to metamorphose into adults and more accurate observations of the nymphal stages would be necessary to establish a marked breeding season, if any.

BELOSTOMATIDAE

Only one species *Sphaerodema molestum* (Duf.) was recorded and that only on a single occasion in September when two specimens were taken.

Two species of *Sphaerodema* occur in Malaya, *S. rusticum* and *S. molestum*. The former is very widely distributed but has so far not been recorded in isolated habitats or at light. Fernando (1960) suggests that it colonizes new habitats by swimming along temporary connections of water during heavy rains. *Sphaerodema molestum* on the other hand is able to fly and colonize habitats. Fernando (1962a) suggests that the genus *Sphaerodema* is being selected for non-flying individuals and that *S. rusticum* has lost its ability to fly recently. This is also true for the Nepidae.

Sphaerodema molestum has been recorded from Malacca (Distant 1906). It has been recorded at light in Malaya by Fernando (1961). In Malaya it is much less common than *Sphaerodema rusticum*. This record is the first of *Sphaerodema molestum* being found in an isolated habitat.

Sphaerodema spp. feed mainly on small aquatic animals chiefly Crustacea and insect larvae. They are important predators of mosquito larvae (Pruthi 1928. Toumanoff 1941).

NAUCORIDAE

Only a single species, *Ctenipocoris asiaticus* Mont. was recorded. This species has not been recorded in Malaya before and as far as I know this is the first record of a naucorid in an isolated habitat. They are generally believed to have lost the ability to fly.

Very few specimens were taken and of these the majority were nymphs. A small breeding population had thus established themselves in the pond.

Little is known of the ecology of *Ctenipocoris asiaticus*. It has been recorded in Burma (Distant 1906, Lundblad 1933). In the surrounding streams a few miles from the pond a number of adults and nymphs were recorded.

CORIXIDAE

Micronecta scutellaris Stal was the only species recorded. It occured in very small numbers only from September onwards. Its absence earlier was probably due to the lack of bottom debris on which this herbivorous species depends. It was also possibly fed upon by the large number of predatory species of Nepidae, Notonectidae and Odonata nymphs.

Although the Corixidae were few in the pond, at least three species were recorded in the vicinity namely, *Micronecta quadristrigata* Breddin, *M. scutellaris* and *M. albifrons*. Motsch. All these are good fliers and perhaps reached the pond in numbers. The absence of two of these species was likely due to the lack of food and predation. By September a certain amount of organic debris had accummulated at the bottom of the pond near the forested edge. It is here that they found both food and shelter. No nymphs were found.

Micronecta scutellaris is the most widely distributed species of *Micronecta* of the South East Asian region. It occurs in China, the Malay Archipelago, Burma, India, Ceylon and in the Ethiopian region. It has been recorded at light by Fernando (1961).

NOTONECTIDAE

Seven species were recorded namely *Anisops occipitalis* Breddin, *A. breddini* Kirk., *A. tahitiensis* Lundb., *A. exigera Horv. Anisops nivea,* (Fieb.) *Enithares mandalayensis* Dist. and *Nychia malayana* Lundb. Both in variety of species and numbers, the notonectids formed the dominant insects living under the water surface.

Two species, *Anisops occipitalis* and *Enithares mandalayensis* occured throughout and were the most numerous. Both these are large species whilst the others were considerably smaller in size. Nymphs were common and belonged chiefly to the two commonest species. They probably enjoyed an abundant food supply.

The Notonectidae are essentially carnivorous (Hungerford 1933, Clausen 1940). In the pond they were probably feeding largely on drowning insects as has been recorded for notonectids before by Walton (1943). They are also important predators on mosquito larvae (Dempwolff 1904, Hinman 1934, Laird 1956). They also feed on a wide variety of aquatic insects including the smaller Hemiptera and Coleoptera. The paucity of mosquito larvae was probably due to the presence of the Notonectidae in large numbers.

Of the seven species of notonectids recorded, *Anisops breddini* and *A. exigera* have been recorded at light (Fernando 1961). Together with the Corixidae they are easily the most mobile of aquatic Hemiptera (Fernando 1962).

PLEIIDAE

Only two specimens of *Plea liturata* (Fieb.) were recorded on a single occasion.

Plea liturata is widely distributed in South East Asia and has been recorded at light by Fernando (1961). In Malaya it occurs commonly in isolated habitats. It is not generally very abundant and its small size makes its collection difficult.

HYDROPHILIDAE

This family was very poorly represented indeed. The total number of species recorded was three and this included 1 *Helochares pallens* MacL.; 2 *Helochares* (*Hydrobaticus*) sp. and 1 *Amphiops pedestris* Sharp. The hydrophilids were however abundant in ponds in the vicinity.

The Hydrophilidae are mainly herbivorous. They often live on muddy bottoms and feed on decaying organic matter. Their food was scarce in the pond and in addition they were probably preyed upon by the larger Dytiscidae which were more abundant.

Of the three species, two, namely *Helochares pallens* and *Amphiops pedestris* have been recorded at light in Malaya by Fernando (1961). These and many other hydrophilids are mobile and fly readily into small habitats.

DYTISCIDAE

Five species were recorded but except for *Hydraticus vittatus* F. they were represented by few specimens. The other species were *Cybister tripunctatus* Ol., *C. sugillatus* Er., *Laccophilus rufulus* Reg. and *Guignotus inconstans* (Reg.). Larvae of *Cybister, Hydraticus* and *Laccophilus* were found but only one of each during the whole period.

The larger Dytiscidae are predatory and so are their larvae. In the pond they probably feed on the relatively small number of aquatic insects and larvae. Perhaps recent arrivals supplied them with an intermittant source of food. There were also large numbers of tadpoles which probably served as food. The smaller species also probably served as food. The smaller species are herbivorous and also probably fed on the dead insects which sank to the bottom after drowning.

The Dytiscidae have been recorded feeding on mosquito larvae by Hinman (1934) and Laird (1947, 1956).

All the species recorded in the pond have been taken at light in Malaya by Fernando (1961).

GYRINIDAE

Only one species namely, *Orectocheilus productus* Reg. was recorded. But it occured in relatively large numbers throughout. In numbers they came after the Gerridae and Notonectidae. Larvae were also found.

The gyrinids, like the gerrids and notonectids feed on dead and drowning insects on the water surface. Their relative abundance adds further evidence to the view that this was the most important source of food in the pond.

AQUATIC INSECTS IN THE VICINITY

Collections of aquatic insects were made in ponds and streams along the Mawai-Sedili Road. Intensive collections were done in Mawai itself in streams and ponds and in Sedili, from marshes. A list of species recorded is given below: *Microvelia douglasi, Mesovelia orientalis, Hydrometra maidli, Ptilomera dromas* Breddin, *Cylindrostethus costalis* Schm. *Limnogonus fossarum, L. nitidus, Metrocoris nigrofasciatus, Rhagodotarsus kraeplini, Laccotrephes simulatus, L. maculatus, Ranatra varipes, Sphaerodema rusticum, S. molestum, Ctenipocoris asiaticus, Micronecta ludibunda* Breddin, *M. scutellaris, M. quadristrigata, Anisops occipitalis, A. exigera, A. breddini, Enithares mandalayensis, Nychia malayana, Plea liturata* (Hemiptera-Heteroptera); *Helochares anchoralis*

Sharp, *H. pallens, H. abnormalis* Sharp, *Paracymus evanescens* Sharp, *Sternolophus rufipes,* F., *Regimbartia attenuata* (F.), *Amphiops pedestris, Enochrus esuriens* (Walk.) *E. rubrocinctus* Reg., *Berosus indicus* Motsch. *Cybister tripunctatus, C. sugillatus, Eretes sticticus* L., *Hydraticus vittatus, H. fabricii* MacL., *Hydrovatus confertus* Sharp., *Hydrovatus* spp. *Copelatus tenebrosus* Reg., *Laccophilus parvulus* Aube, *Guignotus japonicus* (Sharp), *G. inconstans* Reg., *Canthydrus luctuosus* (Aube), *C. flammulatus* Sharp, *Hydrocoptus bosschae* Reg., *Orectocheilus productus* Reg. and *Porrorhynchus marginatus* Cast. Besides these named species there were a large number of unidentified hydrophilids. *Hydrovatus* was represented by at least three species and they were very abundant.

Twenty-four species of Hemiptera were found and of these the stream inhabiting species namely, *Ptilomera dromas, Cylindrostethus costalis* and *Metrocoris nigrofasciatus* were not found in the pond. The other absentees were *Sphaerodema rusticum* which does not fly and *Micronecta ludibunda* and *Micronecta quadristrigata* which perhaps left the pond soon after they arrived or were preyed upon by the larger insects in the water. Of over ten species of Hydrophilidae only three were recorded in the pond. This is a very low proportion considering their ability to fly in great abundance. Over fourteen dytiscid and noterid species were represented in the collections in the vicinity whilst only five species were found in the pond, the carnivorous dytiscids predominating. The Gyrinidae were represented by two identified species *Orectocheilus productus* which was abundant in the pond and *Porrorhynchus marginatus* a stream dweller not represented in the pond.

All the surface living forms in the vicinity were represented except stream dwellers.

ANIMALS OTHER THAN AQUATIC INSECTS

Relatively few animals were found besides the aquatic insects already mentioned. The only vertebrate animal was *Rhacophorus leucomystax* Boulenger whose tadpoles were found in fair numbers until October 1960.

Notable absentees among the invertebrate fauna were the small crustacea (Copepoda, Cladocera).

Insect larvae were found but were never numerous as compared to similar habitats in the vicinity which were older and had vegetation.

Dipteran larvae were few in numbers. Mosquito larvae were practically absent except for a few specimens taken in March 1960. The abundance of Notonectidae was perhaps responsible for this. Hinman (1934) regards the notonectids as the most voracious of aquatic insects feeding on mosquito larvae. Dempwolff (1904) used notonectids to eleminate mosquito larvae in small containers and Laird (1956) considers notonectids as important enemies of mosquito larvae. Chironomid larvae were taken in large numbers in March 1960 but none were recorded before or after. It is probable that the many predators in the pond were responsible for their great reduction or even elimination.

Larvae of Odonata were found in some number throughout. Two of the larger species were bred out by Mr. Khoo Soo Ghee of this Department and identified as *Tramea basilaris burmeisteri* Kirby and *Anax guttatus* Burm. These dragonflies are also predatory and perhaps fed on the adult and larval insects.

Bird visitors to the pond were apparently rare as indicated by lack of footprints and faeces near the bank. I did however observe a sandpiper on one of my visits.

DISCUSSION

The colonization of isolated and artificial habitats have been studied indirectly by collectors in these habitats and also directly by a few workers. This work has been reviewed by Fernando (1958, 1959a). The major contributions to this study has come from Brown (1951) who studied the corixid fauna in a newly constructed pond during the early part of two summers and Fernando (1958, 1959a) who used artificial habitats to study the arrival and departure of aquatic insects in Britain during two years.

In South East Asia very few ecological observations have been made on aquatic insects. Nowrogee (1912) made a study of the life histories of some Indian species. Lundblad (1933) gives many notes on and references to life-histories and Laird (1956) has reviewed the ecology of aquatic species in relation to mosquito ecology in the Pacific area.

In discussing the results of the present investigation I have relied on the works mentioned earlier and also on general works like Ward and Whipple (1941) and Wesenberg-Lund (1951).

The fauna of the pond is in many ways remarkable for its composition and paucity of species. The most numerous animals were insects belonging to three families namely, Gerridae, Notonectidae and Gyrinidae. All these are surface feeding forms. It is very likely that the most important source of food was found at the surface and consisted of dead and drowning insects. This source of food is known to be abundant in some ponds and its importance has been realised by many workers (see Macan and Worthington 1951). In forest areas of Johore, these "jungle ponds" act as very efficient traps for large numbers of terrestrial insects.

Of the other aquatic insects relatively few were found although most families were represented. The fauna in the vicinity was however rich and many of the species found are known to be good fliers from records of light trap catches (Fernando 1961). It is evident therefore that many species did actually reach the pond but were not successful. The successful ones belong to the groups already mentioned and predatory species of Dytiscidae and Nepidae like *Cybister tripunctatus, C. sugillatus, Hydraticus vittatus* and *Laccotrephes simulatus*. These came next in abundance to the Gerridae, Notonectidae and Gyrinidae. These live under the surface and probably fed on aquatic larvae, the few herbivorous forms in the pond and also on new arrivals at the pond which perhaps were numerous considering the mobility of species in the vicinity.

The herbivorous species were extremely few in numbers for two main reasons. The lack of organic matter especially at the earlier stages and the predation by carnivorous species. The absence of effective shelter in the form of aquatic vegetation was perhaps an important factor in increasing the predation of herbivorous species.

The absence of small crustacea (Copepoda, Cladocera) is indicative of isolation from water connection and transport on the feet of birds or other agencies.

Mosquito larvae were very few indeed and this was perhaps due to their predators' being present in large numbers.

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EXPLANATION OF PLATE 1

Above: General view of the pond and surroundings. This picture was taken in April 1961 when the water level was relatively low.

Below: Closeup of pond showing the grasses at the forested edge partly submerged.

Faunal zonation in Mangrove swamps

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(Received March, 1962)

INTRODUCTION

The distribution of animals and plants in a mangrove swamp cannot be described in terms of simple vertical zonation up and down a sea shore. Systems such as that of Stephenson (1949), apply satisfactorily to rocky and sandy shores which are basically two dimensional; but mangrove is a three dimensional community where one could demarcate two main series of zones: (*a*) horizontally from the land towards the sea, and (*b*) vertically from the tree tops down to the soil.

Many physical conditions vary widely within the mangrove area. Thus animals live on such different substrata as roots, stems, and leaves of mangrove trees, dead wood, mud, patches of sand, and so on. Salinity varies widely between high tide when the area is flooded with sea water, and low tide when rivulets of almost fresh water flow to the sea. Further variable factors which affect the occurrence of animals include shade, soil oxygen, alkalinity, and others.

Thus one might expect to find a great diversity of habitats available to the mangrove fauna, and these habitats and their faunas should be inspected before attempting to apply a zonation "system" to the mangrove community.

THE PANDAN MANGROVE RESERVE

Studies were made in the mangrove forest reserve east of the mouth of the Sungei Jurong, off the seaward end of Jalan Penuru in Singapore (Figure 1). The mangrove here has in the past been cut in places, and there is a certain amount of disturbance from shipping in Singapore waters, and from nearby fishing communities[1]. Otherwise it is very similar to mangrove communities which extend along much of the west coast of Malaya, and which have been described by Watson (1928).

During a series of visits to the Pandan Reserve during 1957 and 1958 the author, together with Zoology students of the University of Malaya, examined the distribution of animals, and made counts of the numbers of certain gastropods and of *Uca* sp. in 9th square-metre areas of mud surface, and of bivalves on 50 cm. lengths of mangrove stem or aerial root.

Visits were made mostly at low tide and during daylight, but the area was also visited at night to observe any nocturnal animals and especially the behaviour of *Thalassina,* the mud lobster. During several high neap and spring tides the area was visited to establish these tidal levels with reference to the mangrove trees, animals, and ground levels.

Since rainfall and other climatic fluctuations are minimal in Singapore, it is possible that the fauna and its distribution there remain more constant throughout the year than in regions further from the equator.

[1] At the time of publication, the mangrove forest west of Sungei Jurong is being cleared for industrial projects.

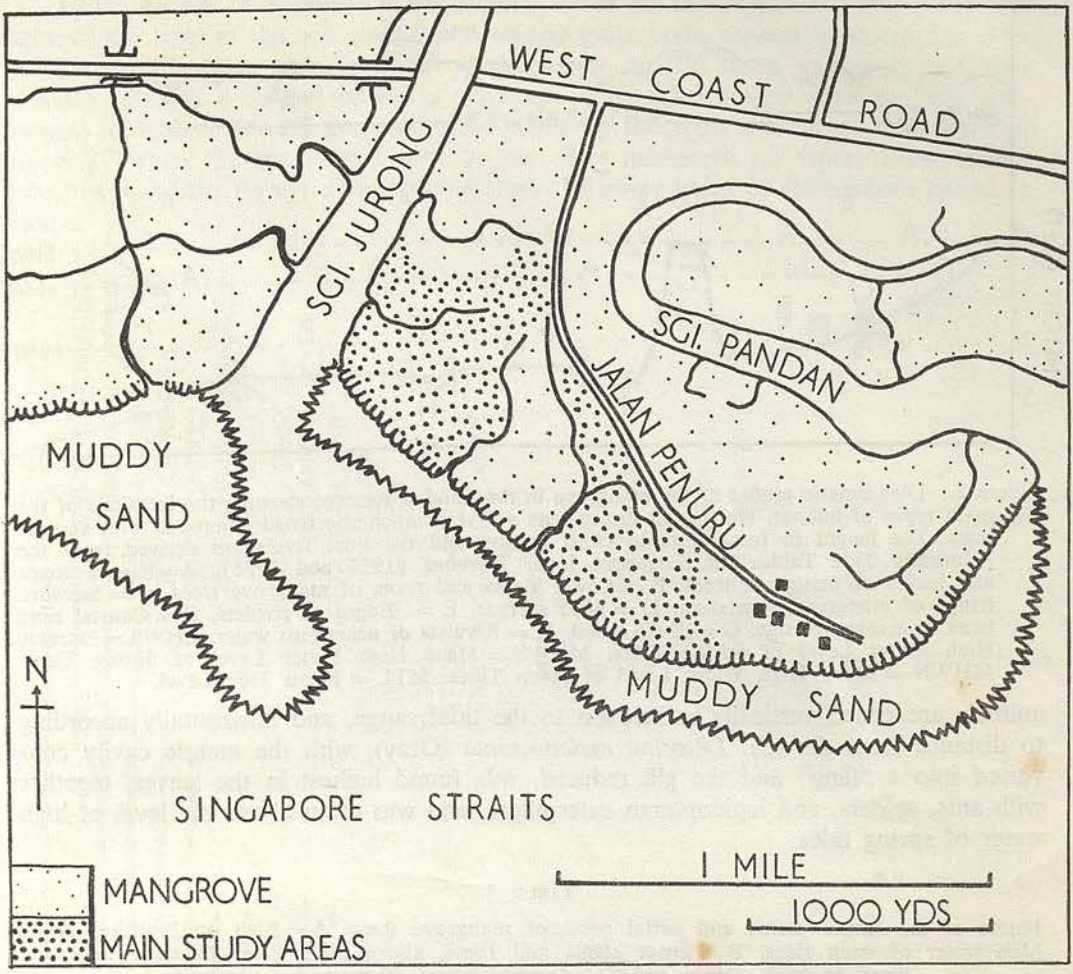

Figure 1. Map of the Pandan Mangrove Forest area, west of Singapore town, showing areas where the main investigations and collections were made.

HABITAT TYPES

Several distinct habitats are readily observable, dependent on various groups of factors such as height within the tidal range, substratum, and distance from the sea. The following are broad habitat groupings, most of which may be further subdivided with respect to one or more environmental features. They are illustrated diagramatically in Figure 2.

LEAVES, STEMS, AND AERIAL ROOTS OF MANGROVE VEGETATION (TABLE 1)

This zone extends vertically from about mid-tide level to above extreme high water of spring tides. In it are found animals which maintain a foothold by various means. Gastropods move by the foot; bivalves attach by byssus and barnacles by cement; crabs walk and climb near the changing water level. Within this general habitat the

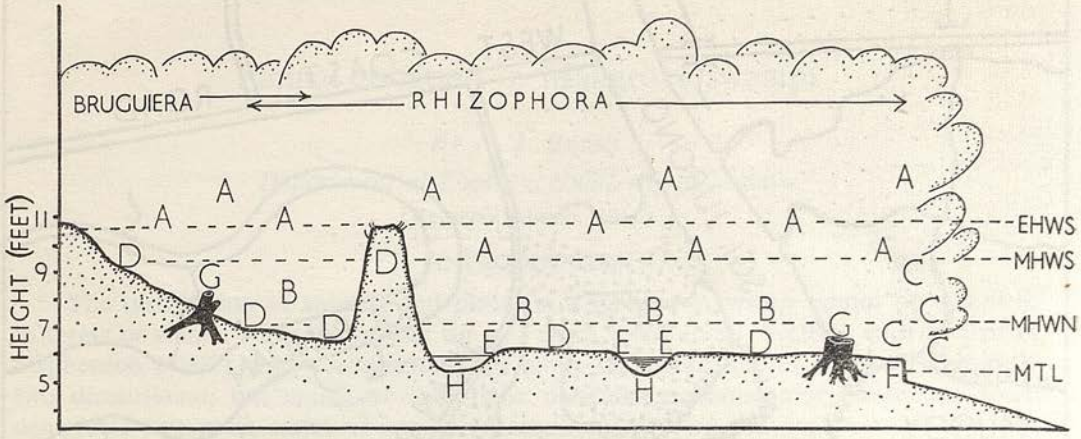

Figure 2. Diagramatic profile of the mangrove in the Pandan Reserve showing the locations of the main types of habitat. Horizontal dimensions are very much shortened compared with vertical ones. The height in feet refers to chart datum, and the tidal levels are derived from the Admiralty Tide Tables for Singapore Inner Harbour (1957 and 1958). A=Higher stems and leaves of mangrove trees. B = Lower stems and roots of mangrove trees. C = Seaward fringe of mangrove vegetation. D = Mud surface. E = Edges of rivulets. F = Coastal mud bank at mangrove edge. G = Dead wood. H = Rivulets of near-fresh water. EHWS =Extreme High Water Level of Spring Tides. MHWS = Mean High Water Level of Spring Tides. MHWN = Mean High Water Level of Neap Tides. MTL = Mean Tide Level.

animals are zoned vertically in relation to the tidal range, and horizontally according to distance from the sea. *Littorina melanostoma* (Gray), with the mantle cavity converted into a "lung" and the gill reduced, was found highest in the leaves, together with ants, spiders, and lepidopteran caterpillars, and was often above the level of high water of spring tides.

TABLE 1

Fauna of the leaves, stems and aerial roots of mangrove trees. A = high on branches above high water of neap tides, B = lower stems and roots, above high water of neap tides and down to mud surface and C = seaward fringe of mangrove vegetation.

Gastropods:				
Littorina scabra L.	A B		*L. melanostoma* (Gray).	A
L. carinifera Menke.	A B		*L. undulata* (Gray).	A B
Nerita birmanica Phil.	B		*N. planospira* Anton.	B
Cassidula mustelina (Desh.)	B		*Ellobium auris-judae* L.	B
Cerithidea quadrata Sow.	B		*Cerithium patulum* Sow.	C
Murex spp.	C			
Arthropods:				
Oecophylla smaragdina Fab.	A		Spiders.	A
Lepidopteran larvae.	A		Lampyrid beetles.	A
Clistocoeloma merguiense de Man.	B		*Ozius guttatus* Milne-Edwards.	B
Sesarma spp.	B		*Grapsus* sp.	B
Balanus amphitrite rafflesi Nilsson-Cantell.	C		*Metapograpsus* sp.	B
Bivalves:				
Enigmonia rosea (Gray).	C		*Isognomon ephippium* (L.).	C
Trapezium sublaevigatum (Lam.).	C		*Barbatia fusca* Brug.	C
Others:				
Trimeresurus purpureomaculatus (Gray).				C

Other species of *Littorina* occur slightly lower on the vegetation, and lower still towards the level of the soil were found several gastropods, especially *Nerita* spp. The pulmonates *Ellobium* and *Cassidula* occurred low on the stems and roots and presumably retained a lungful of air or retreated to air-filled niches when the tide submerged the shore. Several grapsoid crabs move up the roots and stems from the soil especially when the sea level begins to rise. The mangrove pit viper, *Trimeresurus purpureomaculatus* (Gray) was collected from the lower stems of *Rhizophora apiculata* Blume.

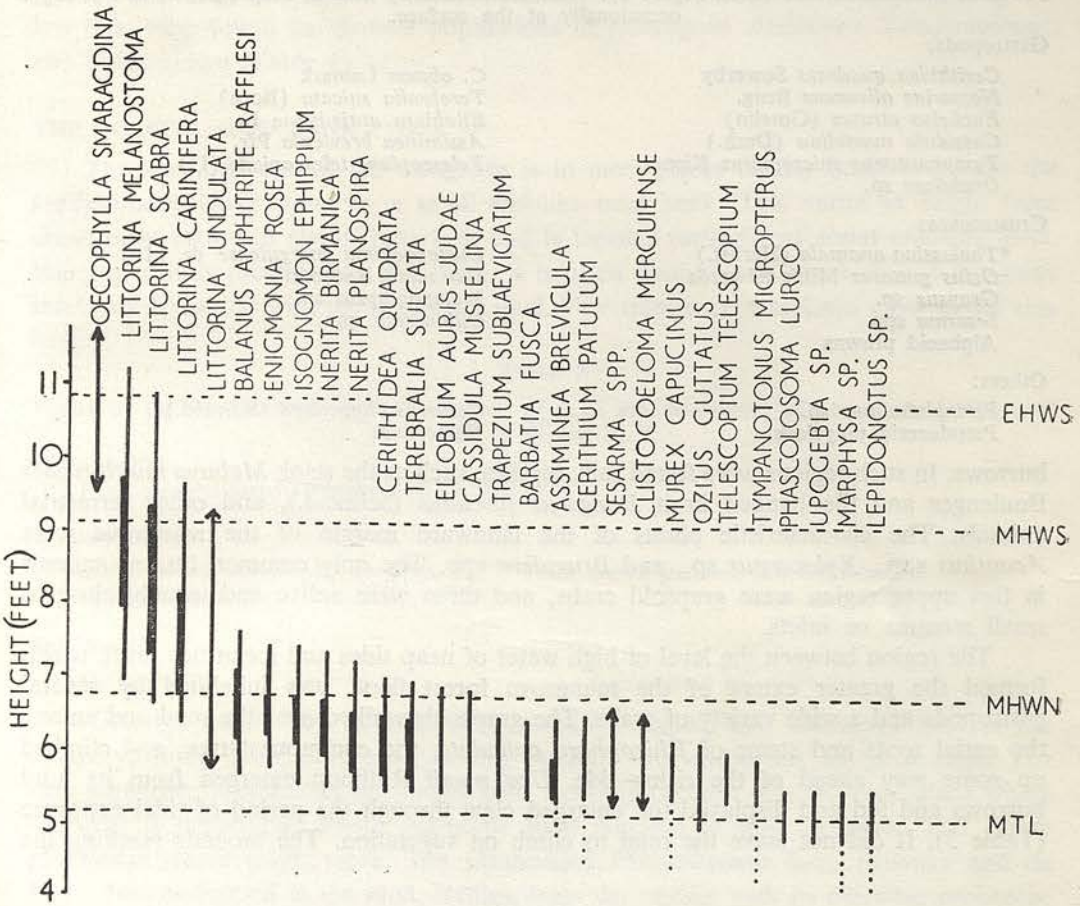

Figure 3. Vertical zonation of the more abundant animals at the seaward edge of the Pandan Mangrove Forest. Thicker lines indicate greater abundance, and arrows indicate movements in relation to tidal oscillation. Dotted lines indicate that the species occurs also on the lower part of the shore beyond the mangrove proper. The heights in feet refer to Chart Datum, and the tidal levels were derived from Admiralty Tide Tables (1957 and 1958).

The barnacles, bivalves, and some gastropods are restricted to the seaward fringe of the mangrove forest. No barnacles or bivalves were found more than 25 metres inland from the forest edge. This is probably a result of their need for minute planktonic food from the open sea, and of their methods of larval settlement from the marine plankton. *Enigmonia rosea* (Gray), a delicate pink or yellow anomiid, was found on the leaves and stems of only those trees nearest the open sea. The vertical zonation of animals in this region is represented in Figure 3.

THE MUD SURFACE (TABLE 2)

This zone extends from the terrestrial region unaffected by the sea, through the littoral region down to about mean tide level or slightly lower. At the highest inland levels, and where bunds had been erected, the commonest animals were insects, and in particular cockroaches. These also inhabit the mounds formed at the tops of *Thalassina*

TABLE 2

Fauna of the mud surface (D in Figure 2). **Thalassina* actually lives in deep burrows and emerges occasionally at the surface.

Gastropods:

Cerithidea quadrata Sowerby
Nassarius olivaceus Brug.
Euchelus atratus (Gmelin)
Cassidula mustelina (Desh.)
Tympanotonus micropterus Kiener
Oncidium sp.
C. obtusa Lamark
Terebralia sulcata (Born)
Ellobium auris-judae L.
Assiminea brevicula Pfr.
Telescopium telescopium (L.)

Crustaceans:

**Thalassina anomala* (Herbst.)
Ozius guttatus Milne-Edwards
Grapsus sp.
Sesarma spp.
Alphaeid prawns
Clistocoeloma merguiense de Man
Uca manii Rathbun
Metapograpsus sp.
Clibinarius spp.

Others:

Periophthalmus sp.
Pseudocerid polyclads
Cerberus rhynchops (Schneid.)
Nemertines

burrows. In such regions were found rats, reptiles, such as the scink *Mabuya multifasciata* Boulenger and the banded krait *Bungarus fasciatus* (Schneid.), and other terrestrial animals. The characteristic plants of the landward margin of the mangrove were *Acanthus* spp., *Xylocarpus* sp., and *Bruguiera* spp. The only common littoral animals in this upper region were grapsoid crabs, and these were active and usually close to small streams or inlets.

The region between the level of high water of neap tides and mean tide level, which formed the greater extent of the mangrove forest floor, was inhabited by several gastropods and a wide variety of crabs. The grapsoids walked over the mud and among the aerial roots and stems of *Rhizophora apiculata,* the commonest tree, and climbed up some way ahead of the rising tide. *Uca manii* Rathbun emerged from its mud burrows and fed and displayed the enlarged claw through the period of tidal exposure (Table 3). It did not leave the mud to climb on vegetation. The mounds marking the

TABLE 3

Numbers of *Uca* burrows in 9th square-metre areas in the Pandan Mangrove Reserve. Counts taken throughout 1958.

	Samples										
Habitat	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Average
Cleared open mud ..	20	4	9	8	17	11	21	5	12	6	11.3
Forest floor	6	5	10	3	8	9	1	7	12	5	6.6

burrows of *Thalassina* were abundant especially where there was a bank or artificial bund. The occupants were never observed during daylight, but were frequently seen carrying mud out to the tops of the burrows at night. The mud skipper, *Periophthalmus* sp. spent much of the low tide period out of water on the mud.

TABLE 4

Numbers of *Assiminea brevicula* in 9th square-metre areas in the Pandan Mangrove Reserve. Counts taken at low tide throughout 1958.

Habitat	Samples 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Average
Within 3 ft. of rivulet	234	109	187	189	224	172	115	146	192	138	170.6
10–20 ft. from rivulet	9	13	2	8	14	10	3	6	12	5	8.2

On the edges of rivulets of near-fresh water which flow to the sea throughout low tide, were found the densest populations of gastropods *Assiminea, Tympanotonus,* and *Telescopium* (Table 4).

THE COASTAL MUD BANK (TABLE 5)

The seaward edge of the mangrove is in most places clearly demarked from the sandy-muddy lower shore by a small cliff-like mud bank. This varies in height from about eight inches to about three feet, and is located vertically at about mid-tide level. Mangrove roots project from the bank, it is often fissured and cracked, and in places sand may be mixed with the mangrove mud. Few trees except saplings grow below this bank.

TABLE 5

Fauna of the coastal mud bank at seaward edge of the mangrove, at about mean tide level (F in Figure 2).

Sipunculoids:

Phascolosoma lurco (Selenka and de Man)

Crustaceans:

Clistocoeloma merguiense de Man
Ozius guttatus Milne-Edwards
Upogebia sp.

Polychaetes:

Marphysa sp.
Lepidonotus sp.

Although hardly any animals were found by digging into the heavy mud of the mangrove forest floor, several burrowing animals live within this marginal zone. The only mangrove polychaetes are found here, possibly because it is the only place where the mud is penetrable, where sea-borne food material is most available, and where planktonic larvae might settle. The sipuncoloid *Phascolosoma lurco* (Salenka and de Man) lives embedded in the mud, feeding from the surface with its eversible proboscis, and polychaete worms, *Upogebia* sp., and *Ozius guttatus* live in ready-made burrows and crevices.

THE DEAD WOOD (TABLE 6)

There are many dead tree stumps and logs in the Pandan reserve, largely as a result of man's activities. Besides the various animals living on the wood surface (gastropods, barnacles, etc.), certain forms are more closely associated with the wood itself. *Ellobium* and *Cassidula* were often found among the dead roots and within the pulpy dead centres of stumps.

TABLE 6

Fauna of dead trees and stumps

Gastropods:	
Ellobium auris-judae L.	*Cassidula mustelina* (Desh.)
Bivalves:	
Martesia striata (L.)	*Teredo* sp.
Crustaceans:	
Limnoria lignorum	*Chelura terebrans*

The bivalves *Teredo* and *Martesia,* the gribble *Limnoria lignorum,* and the amphipod *Chelura* live in burrows in logs and stumps near to the seaward edge, but not in wood deep within the mangrove itself.

THE STREAMS AND RIVULETS

The rivulets within the mangrove bear their own limited fauna. Few fish can tolerate the change from seawater at high tide to almost fresh water at low tide. The most typical inhabitant of the mangrove waters is the mud-skipper *Periophthalmus.* The water snake *Cerberus rhynchops* (Schneid.) is common, and during night observations large numbers of heteronereids were seen swimming up the streams. Marine fish occur in the larger bodies of water which keep contact with the open sea.

DISCUSSION

Clearly the occurrence of animals within the mangrove area depends on many factors. Tidal oscillation is far less dominant over other features than on rocky or sandy shores, and the nature of the substratum and the distance from the open sea are equally important in determining faunal zones. Factors such as shade, salinity, soil oxygen, and soil hardness require more detailed study before their effects can be accurately assessed. Judging from the nature of the fauna, it appears that the mangrove can be divided into a few main zones, and that these may be characterised, as can the zones on other types of shore, by certain biological types.

There is a High Tree Zone characterised by the presence of *Littorina* spp. This may be termed the Littorina Zone and corresponds essentially with that of Stephenson (1949) on other types of shore. There is a Lower Tree Zone characterised by the presence of other gastropods, in particular *Nerita* spp. Both these zones extend from the seaward edge of the mangrove well back toward the landward edge. A third, Marginal Zone, close to the sea edge is characterised by the presence of bivalves which do not occur within the forest. As elsewhere the vertical distribution of the bivalves and barnacles is further governed by the degree of tidal exposure which can be tolerated, and so they do not occur on the tree stems high above the level of high water of neap tides. The mud surface or Ground Zone is rich in crabs, especially *Uca,* which does not leave the mud surface as do most others, and which can be seen in very large numbers between the levels of mid-tide and high water of neap tides. The coastal bank forms a fairly discrete environment rich in burrowing animals, and since burrowers other than crabs are virtually absent from the rest of the mangrove mud, this region might be termed the Burrower Zone.

The five main zones are discrete to the extent that they each provide a different set of environmental conditions, and the occurrence of animals in each zone is determined by their adaptations to different modes of life as dictated by these conditions.

In order to follow the zonation pattern of Stephenson as far as it applies, and at the same time to illuminate the special features which prohibit the application of such a system to mangrove without modification, it might be more suitable to use the terms indicating the characteristic animals rather than those describing the habitat. Thus one might refer to the Littorina Zone, Nerita Zone, Bivalve Zone, Uca Zone, and Burrower Zone rather than to the High Tree Zone, Lower Tree Zone, Seaward Fringe, Mud Surface, and Coastal Bank. These zones may be represented schematically as in Figure 4.

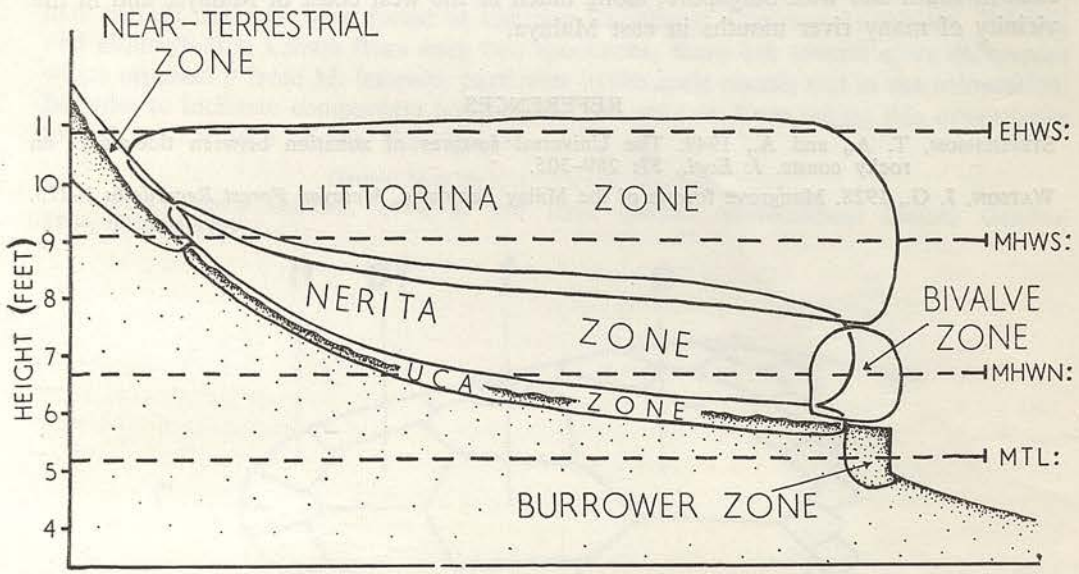

Figure 4. Diagrammatic profile of a mangrove swamp showing a schema of the essential features of animal zonation. Horizontal dimensions are very much shortened compared with vertical ones. The height in feet refers to chart datum, and the tidal levels are derived from the Admiralty Tide Tables for Singapore Inner Harbour (1957 and 1958).

As in all cases of faunal zonation, zones frequently merge and become mixed so that the distinction between them is not clear. In mangrove swamps in Singapore and West Malaya the extent of this mixing depends largely on variation in the substratum and especially on the amount of clearance carried out by man.

Thus in undisturbed mangrove there are very few burrowing animals, apart from *Thalassina* and *Uca,* living in the heavy mud of the forest floor. In the Pandan area small numbers of *Phascolosoma lurco* were found in isolated patches of looser or sandier mud inland from the coastal bank. On shores where there is mixture with sand or where human activity has altered the nature of the mangrove, burrowers are much more abundant. For instance, many polychaetes, bivalves, sipunculoids, and others are found in the greatly disturbed mangrove floor at Kranji, N. Singapore, the mixed mangrove near Port Dickson on the west coast of Malaya, and other areas of mixed or adulterated mangrove.

In such regions many of the animals are those usually associated with other types of shore and especially the muddy-sandy type. Thus bivalves such as *Paphia luzonica* (Sow.), *Anomalocardia squamosa* (L.), *Dosinia rustica* Roemer and *Arca auriculata* (Lam.), and polychaetes such as *Marphysa* sp., *Glycera* sp., *Diopatra* sp. and *Onuphis* sp. are found at Kranji as well as being common on muddy-sandy shores such as Bedok and Mata Ikan on the east coast of Singapore Island.

Where mangrove is mixed with a rocky substratum, as at Port Dickson, the animals occurring in the mangrove include forms more typical of rocky shores such as *Nerita undata* L., *Nerita chameleon* L., *Planaxis sulcatus* Born., and others.

Thus the scheme of mangrove zonation outlined above applies satisfactorily to normal mangrove which has not been too greatly disturbed by man. Such communities exist in south and west Singapore, along much of the west coast of Malaya, and in the vicinity of many river mouths in east Malaya.

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Macrocalamus tweediei, a new species of Reed Snake from Malaya

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(Received May, 1962)

INTRODUCTION

The genus *Macrocalamus* has been previously represented by the single species *Macrocalamus lateralis* Gunther, the Malayan Mountain Reed Snake. The type locality was not recorded but Gunther's specimen was almost certainly Malayan in origin. A new species has now been found at Gunong Brinchang, Cameron Highlands, Pahang, and although it is known from only two specimens, there are several clear differences which separate it from *M. lateralis,* particular in the scale counts and in the colouration. In order to facilitate comparison between the two species, I am taking this opportunity to add to Gunther's original description.

Genus *MACROCALAMUS* Gunther, 1864

Macrocalamus Gunther, 1864, p. 198 (type species: *Macrocalamus lateralis* Gunther, 1864, by monotypy).

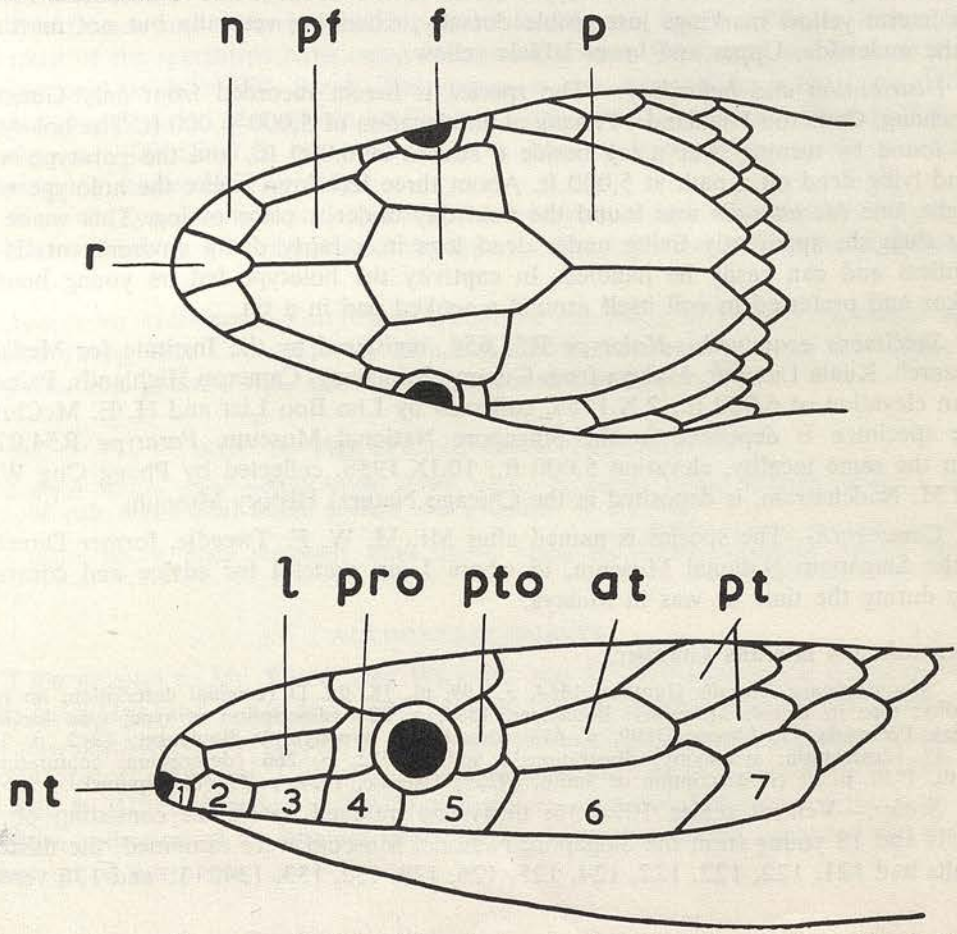

Figure 1. *Macrocalamus tweediei* Lim, (above) dorsal and (below) lateral view of head. (at= anterior temporal, f = frontal, l =loreal, n = nasal, nt = nostril, p = parietal, pf = prefrontal, pro = preocular, pt = posterior temporal, pto = post-ocular, r = rostral).

The rostral scale is longer than broad, extending to the surface of the head, separating the nasals, and meeting the prefrontals. The nostril lies between a nasal scale and the first upper labial. A loreal scale is present but there is no internasal. One preocular and one post-ocular. Subcaudals in two rows.

Macrocalamus tweediei sp. nov. Text-fig. 1; Plate 2.

Scales.—Rostral scale longer than broad, separating the nasals and coming in contact with the prefrontals. The frontal is slightly longer than broad, and shorter than the parietals. One preocular and one post-ocular. A loreal present, twice as long as broad, touching the 2nd and 3rd upper labials. One anterior and two posterior temporals, but no internasal. Ventrals and subcaudals of the male specimen (holotype) are 134 and 32; the ventrals of the female specimen (paratype) are 147, but with the tail damaged and the subcaudals incomplete. Anal scale entire; mid-body scales in 15 rows; 7 upper labials, the 4th and 5th touching the eye. The holotype measures 17 inches (500 mm.), and the paratype, in which part of the tail is missing, measures only 14 inches (348 mm.).

Colouration.—Uniformly black above, with black and yellow checkered pattern below. The tail of specimen R54,070 (paratype) has a median subcaudal black line, whereas in specimen R57,656 (holotype) the median subcaudal line is obscured. Head with lateral yellow markings just visible dorsally, extending ventrally but not meeting on the underside. Upper and lower labials yellow.

Distribution and behaviour.—The species is herein recorded from only Gunong Brinchang, Cameron Highlands, Pahang at an elevation of 5,000–6,000 ft. The holotype was found by turning over a log beside a stream at 6,000 ft., and the paratype was found lying dead on a path at 5,000 ft. About three feet from where the holotype was caught, one *M. lateralis* was found the next day under a piece of log. This snake is very sluggish, apparently living under dead logs in a fairly damp environment. It is harmless and can easily be handled. In captivity the holotype fed on young house-geckos and preferred to coil itself around a soaked pad in a tin.

Specimens examined.—*Holotype* R57,656, registered by the Institute for Medical Research, Kuala Lumpur, Malaya from Gunong Brinchang, Cameron Highlands, Pahang at an elevation of 6,000 ft., 2.X.1959, collected by Lim Boo Liat and H. E. McClure. The specimen is deposited in the Singapore National Museum. *Paratype* R54,070, from the same locality, elevation 5,000 ft., 10.IX.1958, collected by Phang Ong Wah and M. Nadchatram, is deposited in the Chicago Natural History Museum.

Comments.—The species is named after Mr. M. W. F. Tweedie, former Director of the Singapore National Museum, to whom I am grateful for advice and constant help during the time he was in Malaya.

Macrocalamus lateralis Gunther.

Macrocalamus lateralis Gunther, 1864, p. 199, pl. 18, fig. D (original description; no type locality; type in British Museum); Boulenger, 1894, p. 327 (description of type; type locality: Malay Peninsula ?); Flower, 1899, p. 673 (description; synonymy); Boulenger, 1912, p. 153, fig. 47 (description; synonymy; illustrations); Smith, 1922, p. 266 (description; colouration); Smith, 1930, p. 57 (re-description of Smith, 1922); Tweedie, 1957, p. 55 (description).

Scales.—Ventral scales 109–136; thirty-one unsexed specimens consisting of 13 adults and 18 young from the Singapore National Museum were examined; the thirteen adults had 121, 122, 122, 122, 124, 125, 126, 129, 132, 133, 134, 135 and 136 ventral

scales, and eighteen young had 109, 110, 111, 112, 112, 113, 113, 115, 116, 117, 119, 120, 121, 122, 123, 124, 129 and 130 ventral scales. Subcaudals 18–30. In addition, 12 adult specimens of the Institute collection, consisting of 6 males and 6 females, were examined. Ventrals and subcaudals of 6 males specimens are 115–128 and 24–29, and those of the 6 females are 129–136 and 21–24 respectively. Anal scale entire; scales in mid-body, 15 rows; 8 upper labials, 4th and 5th touching the eye; a loreal scale present. Head small and wedge-shaped, tail tapering and pointed. Grows to about 15 inches (450 mm.) long.

Colouration.—Adult reddish-brown above, with or without V-shaped markings on the head, neck, and the nape, frequently without such markings. Yellow or orange underneath. The ends of the ventrals are bordered with dark-brown. Tail with or without a median subcaudal line.

Young specimens are more lightly coloured than adults and are orange-brown above with two rows of yellow spots on the back running from the nape towards the end of the tail. The head and neck are patterned with two or more V-shaped markings. The lowest row of the dorsal scales paler, forming pale-yellow longitudinal lines immediately above the dark-brown edges of the ventrals. Orange or pinkish underneath. The labials of both ages are yellow.

Distribution and behaviour.—This snake is common in the Malayan mountains, and most of the specimens have come from the Cameron Highlands and Fraser's Hill, Pahang, or Maxwell's Hill, Perak. The species is also reported from the Larut Hills, Perak, at an elevation of 4,400 ft. by Flower (1899, p. 673), and from Gunong Tahan, Pahang, at 5,400–5,700 ft. by Smith (1922, p. 266). It is reported to feed on worms and slugs (Tweedie, 1957, p. 55).

Since the species was first described, all subsequent records have been from various localities in Malaya. I hereby restrict the type locality to Cameron Highlands, Pahang, Malaya.

Specimens examined.—Forty-three specimens consisting of twenty-five adults and eighteen young were examined. All were collected at various time from the Cameron Highlands and Fraser's Hill, Pahang, and Maxwell's Hill, Perak.

KEY TO THE SPECIES OF *MACROCALAMUS*

8 upper labials, body reddish-brown above, yellow or orange below, with or without a pair of pale longitudinal bands towards the underside of the body ..... *Macrocalamus lateralis* Gunther

7 upper labials, body uniformly black above, black and yellow checkered pattern below ..... *Macrocalamus tweediei* Lim

ACKNOWLEDGEMENTS

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EXPLANATION OF PLATE 2

Ventral aspect, of (*above*) *Macrocalamus tweediei* Lim and (*below*) *M. lateralis* Gunther.

Some helminth parasites of Malayan reptiles [1]

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(Received July, 1962)

INTRODUCTION

REPTILES ARE HOSTS to a wide variety of trematode, cestode and nematode parasites. Yet relatively little is known about these parasites in Malaya. In neighbouring countries such as the Philippines, Indonesia, India and Ceylon, however, the parasitic fauna of reptiles is better known.

An examination of the available literature on helminth parasites of reptiles of Malaya together with studies on local material shows that helminths infecting Malayan reptiles are generally of the same species as those found in neighbouring countries in South East Asia. But detailed anatomical studies however, show that slight morphological variations do occur between the Malayan material and those from neighbouring regions. This is to be expected.

Of the helminths recorded in the present paper all but one trematode species (*Paradistomoides malayanum* sp. nov.) have been previously described. Nevertheless most of them are new records for Malaya.

Some interesting features concerning the taxonomy of reptile helminths have also arisen out of the present study. It has shown that the ultimate position of organs such as vitellaris, testis, ovary and acetabulum, in stained preparation of the trematode *Paradistomoides orientale* (Narain & Das) may be considerably influenced by the preserving and pre-staining techniques used. Hence the relative positions of these organs is not a very reliable character for use in the taxonomy of this group.

Another feature of interest concerns the pseudophyllid cestode *Duthiersia sarawakensis* Woodland, 1938. Woodland (1940), in revising the genus *Duthiersia,* left undecided the validity of this species. The present study shows that *D. sarawakenis* is probably a juvenile form of *D. expansa* Perrier, 1873.

A third noteworthy finding is the presence of eggs in the male of *Abbreviata varani* (Parona, 1889). Although the presence of eggs in male physalopterids has been reported by Cruz (1950) and Tromba et al. (1958), this additional record indicates that this phenomenon is probably widespread in certain physalopterids.

MATERIALS AND METHODS

The investigations described herein are based mainly on helminths collected from local reptiles. In all, eight different species of reptile hosts were examined. The helminths recovered from these animals include five trematode, two cestode, and seven nematode species.

The worms recovered from the hosts, were transferred to normal physiological saline and later treated as follows:—

Trematodes.—Some were pressed before fixation and others were fixed directly in Bouin. Only pressed specimens were used for stained preparations, of whole mounts.

[1] Part of a thesis accepted by the University of Singapore for a M.Sc. degree.

For sectioning, however, unpressed or lightly pressed specimens were used. Whole mounts were stained with Borax Carmine or Delafield Haematoxylin, and sections in Heidenhain's Iron Haematoxylin.

Cestodes.—Both Bouin and formal saline were used for fixing tapeworms. The latter fixative was found to give better results in staining, particularly with Erhlich and Delafield Haematoxylin.

Nematodes.—The nematodes were fixed in warm (70° C) 70% alcohol and later transferred to fresh 70% alcohol and stored. They were examined in lactophenol or creosote.

TREMATODA

The following species were recovered from the local reptile hosts—*Mesocoelium meggiti* Bhalerao, *Euparadistomum varani* Tubangui, *Paradistomoides orientale* (Narain and Das), *Paradistomoides malayanum* sp. nov. and *Quasichiorchis purvisi* (Southwell and Kirshner). Of these, only *Q. purvisi* has been previously recorded from Malaya.

A preliminary study was also made of the pathological changes in the stomach of *Heosemys grandis* (Gray) due to infection with *Quasichiorchis purvisi.*

Mesocoelium meggitti Bhalerao, 1927. (Figure 1C).

Material examined.—Three specimens were obtained from the small intestine of a Ground Lizard, *Mabuia multifasciata* (Kuhl), taken on the campus of the University of Singapore on 18.5.60. They were found loosely attached to the wall of the intestine.

Description.—They measure 2.15–2.88 × 0.62–0.75[2]. They are elongate and broader anteriorly than posteriorly. The cuticle in the anterior third to half of the body bears minute spines. The oral sucker is ventro-terminal. The ventral sucker is situated within the anterior third of the body and is much smaller than the oral sucker. It measures 0.14–0.16.

The mouth is ventro-terminal and is surrounded by a prominent oral sucker whose diameter is 0.24–0.26. It is separated from the pharynx by a short prepharynx. The pharynx is muscular and measures 0.07–0.08 × 0.09–010. The pharynx leads into the oesophagus which measures 0.11–0.15. The bifurcation of the caecae takes place at about ¼ distance of the body length from the anterior end. The caecae are narrow and terminate at a level between half and two-thirds of the body length.

The testes are situated intracaecally, one on either side of the acetabulum. They are preovarial They are oval in shape with smooth margins, are of equal size and measure 0.25–0.29 × 0.19–9.21. The left testis is slightly in advance of the right.

The ovary is post-testicular and displaced the left of the median line. In some specimens it is directly opposite the right testis. The ovary is oval and measures 0.14–0.17 × 0.11–0.13. The shell gland is diffuse and situated on the right side of the ovary.

The cirrus sac is small and elongate. It measures 0.13–0.15. It is situated along the median line approximately midway between the pharynx and acetabulum. It encloses the seminal vesicle, pars prostatica and the cirrus. The common genital opening is situated slightly to the right of the median line at a level approximately halfway along the oesophagus.

Most of the uterine coils are post-testicular. The uterus is in two loops—a descending loop containing less mature colourless eggs and an ascending loop with yellow to dark brown eggs. Mature eggs are operculated and measure 31–34u × 21–25u.

[2] All measurements given in this paper, unless otherwise stated, are in millimeters.

Vitellaria are in distinct follicles. They are extracaecal and extend from the posterior level of the oral sucker to just anterior to the caecal termination.

Excretory canals are situated one on either side of the body. They appear to converge just posterior to the shell gland and extend posteriorly to drain into the excretory bladder at the posterior end of the body. The excretory bladder is more dilated than the remaining canals. The excretory pore is terminal.

Discussion.—Mesocoelium meggitti was first described from the ground lizard *Mabuia dissimilis* Hallow, in Rangoon. Tubangui (1931) recovered several young and mature individuals of the parasite from *M. multifasciata* in the Philippines. Tubangui's studies show that Bhalerao's material were young specimens. Chatteriji (1940) recorded *M. sociale* Luhe, 1901 from the intestine of *Ptyas mucosus* in Rangoon. He claims that *M. meggitti* resembles *M. sociale* in all essential characters and therefore treats it as a synonym. Examination of the local material however shows that the two species are distinct. This view is also shared by Cheng (1960), who separates the two species on the basis of characters such as position of genital pore and shape of excretory vesicle. The genus *Mesocoelium* has hitherto not been reported in Malaya.

Euparadistomum varani Tubangui, 1931. (Figure 1D).

Material examined.—Two mature individuals of the parasite were recovered from the gall bladder of a Monitor Lizard, *Varanus nebulosus* (Gray), captured at the 7½ mile Kota Tinggi—Mawai Road, Johore. Presence of the worm was noticeable through the wall of the gall bladder. In the living condition they are leaf-like and have a wrinkled appearance.

Description.—They measure 3.0–3.5 × 1.82–2.5. They are broad, flat and attenuated at both ends, being more pointed anteriorly than posteriorly. The cuticle is smooth. The oral sucker is subterminal and measures 0.66–0.83 in transverse diameter. The ventral sucker is situated close to the equator of the body. It measures 0.31–0.54.

The mouth is subterminal. It is surrounded by a well developed oral sucker. The mouth leads into the pharynx (prepharynx absent). The pharynx is muscular. It is broader than long and measures 0.16–0.18 × 0.18–0.23. The oesophagus is 0.16–0.18 long. The oesophagus bifurcates at a level midway between the genital pore and the pharynx. The caecae extend to a level more than ¾ the body length from the anterior end. They do not however reach the caudal end of the body.

The testes are more or less oval with smooth margins. They are intracaecal and directly preacetabular. They are at tandem and measure 0.18–0.22 × 0.11–0.18.

The cirrus sac is elongate, measuring 0.19–0.21 × 0.06–0.07. It is situated along the median line approximately midway between the oral and ventral suckers. The cirrus sac encloses a coiled seminal vesicle, pars prostatica and a cirrus. The common genital opening is posterior to the intestinal bifurcation.

The ovary is rounded or oval with smooth margins. It is a little larger than the testis and measures 0.20–0.32 × 0.18–0.22. It is situated directly behind the acetabulum close to the median line. The shell gland is distinct and situated on the posterio-mesial side of the ovary.

The uterine coils are profusely distributed. In one specimen the uterus extends as far forwards as the lateral sides of the oral sucker. The uterine coils are not distinguishable into an ascending and descending loop. Mature eggs in the uterus are brownish yellow in colour, and measure 39–42u × 23–24u.

Vitellaria are extracaecal and extend from the level of the testes to almost the level of termination of the intestinal caecae.

The excretory bladder is Y-shaped. The excretory pore is situated at the posterior tip of the body.

Discussion.—E. varani was first described from the gall bladder of *Varanus salvator* L., in Luzon, Philippines. However, the writer has not found the parasite in any of the eighteen individuals of the same species of host examined locally. The parasite was instead recorded from *V. nebulosus,* a forest-dwelling lizard.

Paradistomoides orientale (Narain & Das, 1929). (Figure 1A).

Material examined.—Specimens were collected from the gall bladder of the Tree Lizard, *Calotes cristatellus* (Kuhl), caught in the campus of the University of Singapore. In all, five specimens were obtained, two from one individual and three from another. In addition to these, stained preparations of numerous individuals of the parasite from Ceylon taken from *C. versicolor* (Daud.) were also available for study.

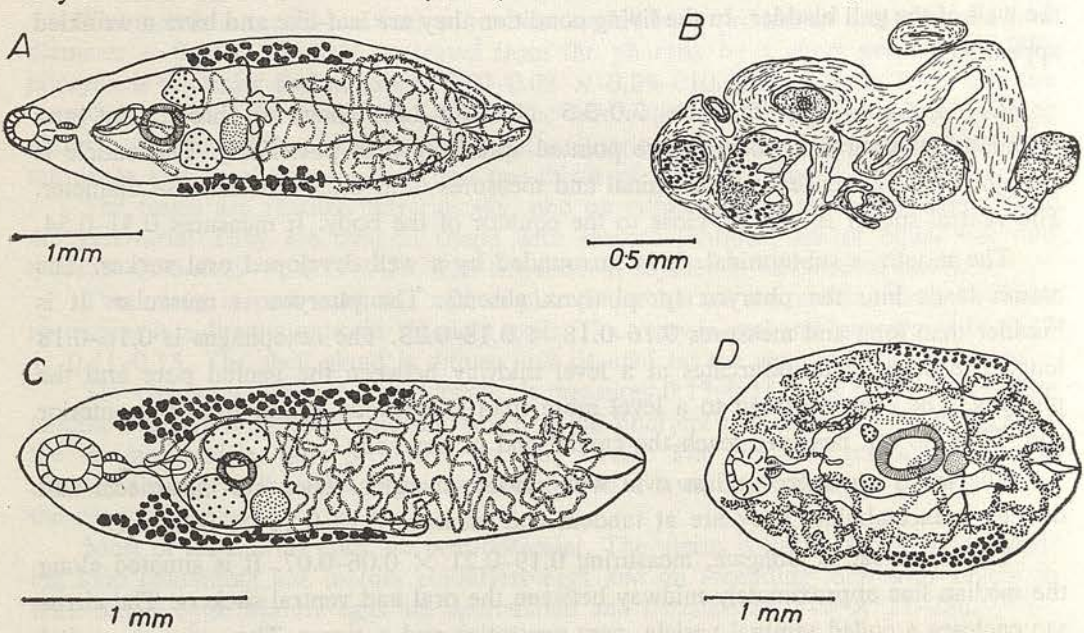

Figure 1. (A) *Paradistomoides orientale.* (B) Infected liver showing *P. orientale.* (C) *Mesocoelium meggitti.* (D) *Euparadistomum varani.*

Description.—The body is flattened, leaf-like and narrow anteriorly. It measures 4.32–6.11 long, and 1.33–2.83 broad at the region of maximum breadth, which is the region of the ventral sucker. The oral sucker is subterminal and has a diameter of 0.36–0.37. The ventral sucker lies about $\frac{1}{4}$ distance of the body length from the anterior end. It measures 0.32–0.54. The excretory pore is situated at the posterior end of the body. The genital opening is situated at the level of the caecal bifurucation or a little anterior to it.

The mouth is situated antero-ventrally. It leads directly into a pharynx (prepharynx absent) which measures 0.15–0.19 in diameter. The oesophagus is short and bifurcates at a level midway between the ventral sucker and the anterior end of the body. The caecae extend to almost the posterior end of the body.

The testes are rounded and measure 0.23–0.31 in diameter. They lie at a level approximately $\frac{1}{3}$ body length from the anterior end. They are post acetabular or extend a short distance in front of the posterior margin of the ventral sucker. The vasa efferentia arise on the mesial side of the testes and pass anteriorly. They unite in the mid-line at a level between the acetabulum and the caecal bifurcation to form the vas deferens. The cirrus sac is long and cylindrical. It is ventral to the intestine. The vas deferens become dilated at the posterior end of the cirrus sac to form the vesicula seminalis, which occupies approximately $\frac{1}{3}$ the posterior portion of the cirrus sac. The cirrus is thick walled. It is surrounded by prostate cells.

The ovary is rounded and slightly lobed. It measures 0.37–0.49 in diameter. It is situated in the median line, and is post testicular. The oviduct arises from the mid-dorsal region of the ovary. The shell gland lies at the posterio-lateral angle of the ovary. The vitellaria occupy approximately the middle $\frac{1}{3}$ of the body and partly overlap the caecae. They are made up of large numbers of close-set follicles. Two vitelline ducts arise on each side from the vitellaria and unite to form prominent transverse ducts which join the vitelline reservoir, which is situated close to the shell gland.

The uterus occupies the posterior $\frac{3}{4}$ of the body but does not extend into the region of the vitellaria. The anterior limit of uterine distribution is the intestinal bifurcation. Posteriorly it extends as far as the body extremity. The eggs measure 0.032×0.023. The excretory bladder is spherical in shape and the excretory pore is terminal.

Discussion.—*Paradistomoides orientale* was originally assigned to the genus *Dicrocoelium* but Bhalerao (1936) transferred the species to the genus *Paradistomum* Kossack, 1910. Later, Travassos (1944) transferred the species to a new genus *Paradistomoides*.

The erroneous erection of the new species, *Paradistomum moghei,* by Bhalerao (1936), appears to have been due to the use of characters involving the relative position of organs such as vitellaria, testes and ovary. Krishnaswami and Anantaraman (1956) showed that these characters are variable in *P. orientale* and that *P. moghei* is in fact a juvenile form of *P. orientale.*

The present study also shows that organ position and size is variable in *P. orientale*. Examination of the local as well as the Ceylon material showed that width of caecae, testis size, and relative position of organs such as vitellaria, testis and ovary are variable in this species. A study was therefore made of the living material before and after fixation in order to determine the changes in the relative position of organs in the two states. Three living individuals of *P. orientale* were transferred to 0.01% aquaeous neutral red and the position of the organs was determined and recorded with the aid of a camera lucida (Figs. 2 A_1, B_1, C_1). They were then fixed in bouin, one by one, between two coverslips and re-examined after staining with borax carmine. It was found that the position of most organs had altered considerably (Figs. 2 A_2, B_2, C_2). These changes were inconsistent in the three specimens.

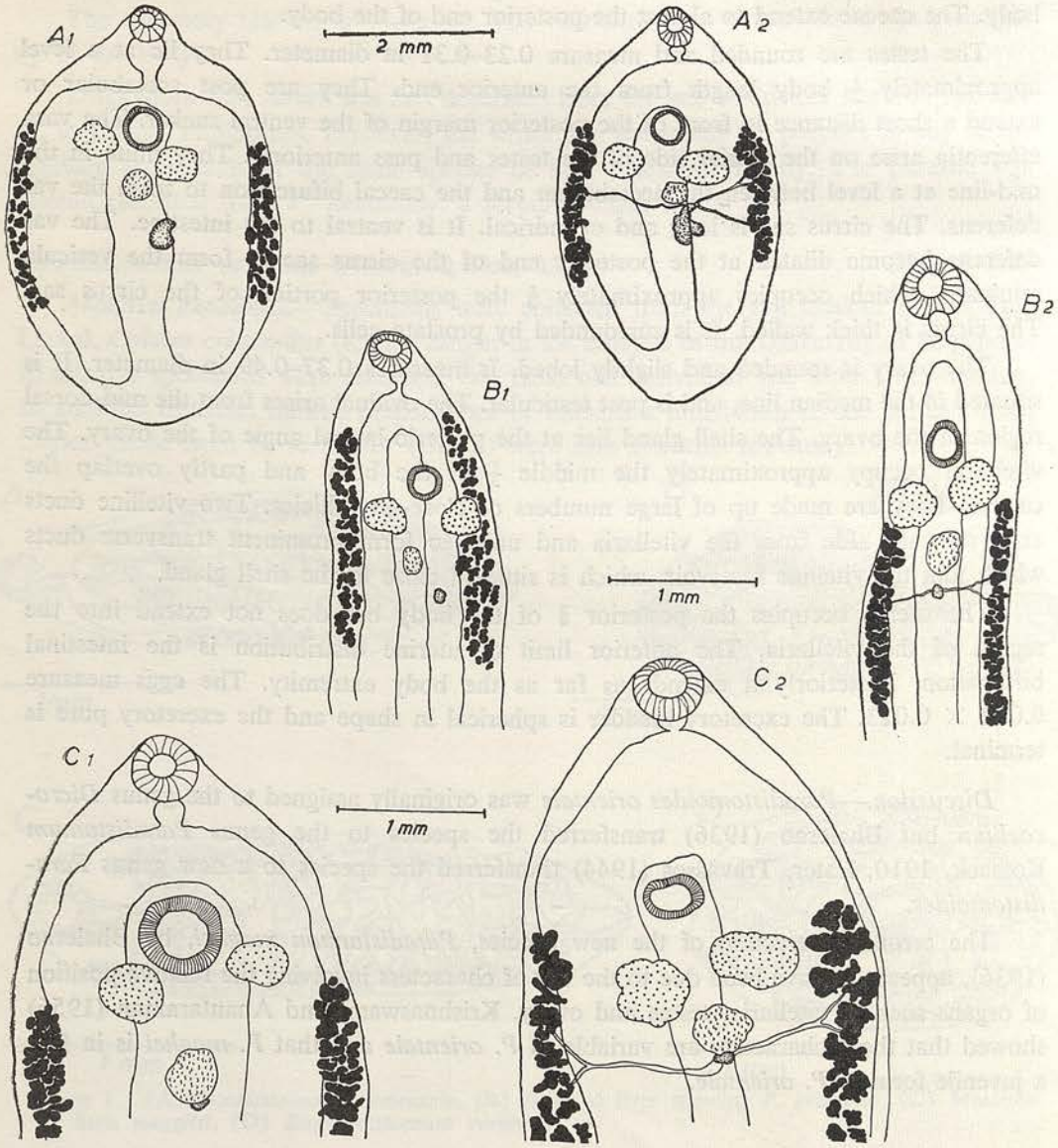

Figure 2. *Paradistomoides orientale*. Relative position of organs before, and after fixation.

It is possible that the position of organs in stained preparations of *P. orientale,* depends on the state of the worm (i.e. contracted or expanded) at the time of fixation. It is perhaps also influenced by the pressure due to the coverslip during fixation. As these are often variable, the position of organs would also tend to vary. Hence these characters are probably not reliable for use in the tamonomy of this group.

Notes on Infection.—P. orientale recovered from the local reptiles were all taken from the gall bladder of the animals. Examination of serial sections of infected liver of *Calotes versicolor* from Ceylon, showed presence of mature worms in the bile duct as well. The worms were found attached to the walls of the bile duct. The duct wall showed signs of fibrosis.

All the known records of *P. orientale* are from the gall bladder of the host, but study of the Ceylon material shows that worms do migrate into the bile duct, and may even remain attached to it. This may possibly be due to heavy worm burden and lack of 'living space' in the gall bladder of the host. The presence of the worm in the bile duct appears to result in pathological changes (fibrosis) of the duct wall.

Paradistomoides malayanum sp. nov. (Figure 3).

Material examined.—Two specimens, the types, were obtained from the gall bladder of a House Snake, *Lycodon aulicus* (L.), collected in Singapore. Six other individuals of *L. aulicus* were examined but none of them were found infected. The worms were visible by transparency through the wall of the gall bladder. They were not attached to the walls. In life, the worms are creamy white in colour. Of the two worms collected one was serially sectioned for detailed anatomical studies and a whole mount preparation was made of the other.

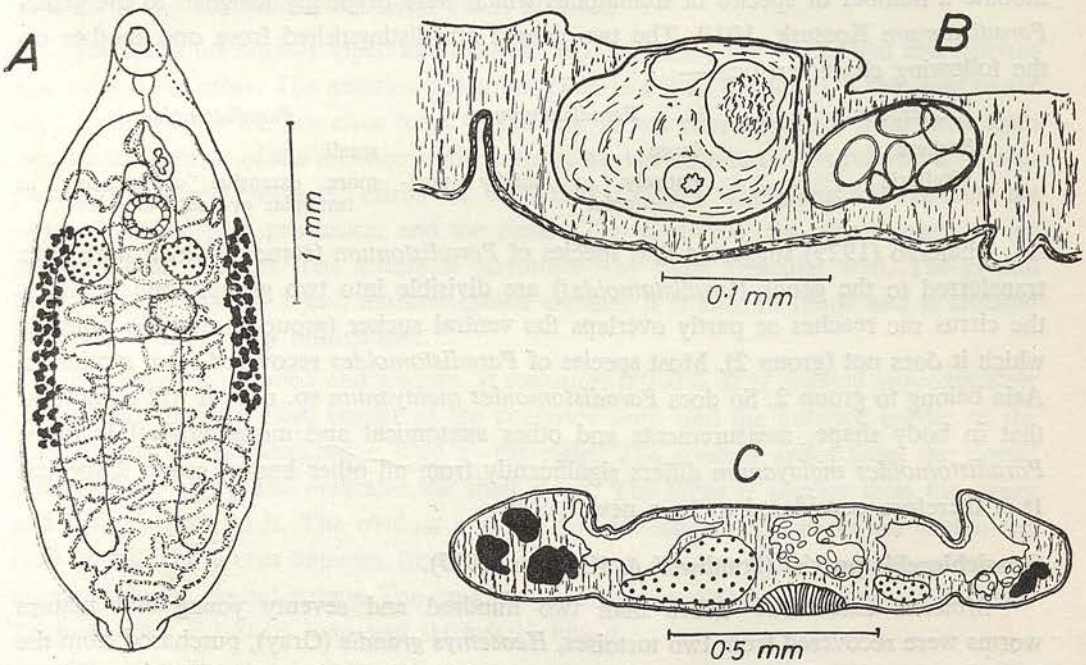

Figure 3. *Paradistomoides malayanum* nov. sp. (A) Whole mount. (B) T.S. in region of cirrus sac. (C) T.S. in acetabular region.

The types are deposited in the National Museum, Singapore.

Description.—The body is leaf-like, broad posteriorly and tapering anteriorly. It measures 3.72–3.81 long and 1.42–1.43. The cuticle is devoid of spines, but bears minute papillae in the posterior ⅓ of the body. The mouth is ventro-terminal and surrounded by an oral sucker which measures approximately 0.34 long and 0.26 broad. The ventral sucker is approximately of the same diameter as the oral sucker. It is situated medially closer to the level of the testes than to that of the caecal bifurcation. It measures 0.35–0.36 × 0.133–0.134. The common genital opening is median and ventral to the bifurcating caecae.

The ovary is situated a little to the left of the midline, immediately behind the left testis. It is almost circular with a smooth margin, and measures 0.22–0.27 in diameter. The shell gland is latero-medial and adjacent to the ovary. The vitellaria occupy approximately the middle third of the body. They are extracaecal and consist of numerous closely-set follicles. Two vitelline ducts leave the vitellaria on each side. These unite to form a more prominent transverse duct which leads to the vitelline reservoir situated close to the shell gland. The uterine coils are confined to the body region posterior to the caecal bifurcation. They do not extend into the region of the vitellaria. The eggs are oval, thick shelled and measure 0.036 × 0.018. The excretory pore is median and posterio-terminal. The excretory bladder is narrow and cylindrical.

Discussion.—The genus *Paradistomoides* Travassos, 1944, was set up to accommodate a number of species of trematodes which were originally assigned to the genus *Paradistomum* Kossask, 1910. The two genera are distinguished from one another on the following characteristics:—

Character.	*Paradistomum.*	*Paradistomoides.*
Suckers	large	small
Vitellaria	entirely or chiefly post-testicular.	more extensive commencing at testicular or acetabular level.

Bhalerao (1929) suggested that species of *Paradistomum* (some of which were later transferred to the genus *Paradistomoides*) are divisible into two groups, one in which the cirrus sac reaches or partly overlaps the ventral sucker (group 1) and the other in which it does not (group 2). Most species of *Paradistomoides* recovered from reptiles in Asia belong to group 2. So does *Paradistomoides malayanum* sp. nov. It will be noticed that in body shape, measurements and other anatomical and morphological features, *Paradistomoides malayanum* differs significantly from all other known group 2 species. It is therefore considered to be a new species.

Quasichiorchis purvisi (Southwell & Kirshner, 1937).

Material examined.—More than two hundred and seventy young and mature worms were recovered from two tortoises, *Heosemys grandis* (Gray), purchased from the Sago Lane market in Chinatown, Singapore on 11.3.60 and 31.3.60. The worms were found firmly attached to the stomach wall of the hosts.

Description.—They measure 8.1–12.4 long, and 1.23–2.46 broad at the region of maximum breadth (mid-region of the body). The thickness varies from 0.76–1.31. Young worms are more fusiform in shape than mature ones. The dorsal aspect of the adult worms is convex while the ventral is either flat or slightly concave. In the living state they are white in colour. The cuticle is smooth except in the region of the mouth, which is surrounded by small papillae. The acetabulum is terminal and circular in shape. It measures 1.72–2.44 in diameter. Its opening is directed postero-ventrally and measures approximately 0.7. The depth of the acetabulum varies from 0.9–1.2.

The oral sucker is prominent. It is terminal in position. The ratio of the length to breadth of the oral sucker ranges from 1:1 in young worms to 3:2 in mature forms. The depth of the sucker varies from 0.4–1.1. The oral sucker is flattened dorso-ventrally and dilated posteriorly. A pair of oral diverticula arises posteriorly and from the dorso-lateral aspect of the oral sucker. The diverticula are globular in shape and smaller than the oral sucker. The oesophagus arises from the posterior and ventral median region of the oral sucker. It measures 1.12–2.26 long and is divided into three parts—a thin anterior portion, a thick muscular mid-portion, and a very short and dilated posterior pharyngeal portion. The anterior portion of the oesophagus is shorter and approximately half as broad as the mid-portion. The pharyngeal portion is separated from the mid-portion by a weak constriction. The intestinal caecae arise almost at right angles to the pharynx and pass median to the vitellaria and dorso-lateral to the testis. They end just in front of the acetabulum but never reach its level.

The testes are slightly lobed and measure 0.5–1.6. They are intracaecal and situated one behind the other. The anterior testis, however, is a little displaced to the right of the median line. So is the posterior testis to the left. A vas efferens arises from each testis and unites in front of the anterior testis to form the vas deferens. This follows a sinuous path forwards and enters the cirrus sac at its dorsal aspect. The cirrus sac contains the seminal vesicle, pars prostatica, and the cirrus. The duct from the cirrus pouch to the genital atrium is short. The atrium is surrounded by thick muscular wall. The genital pore is at the base of a well marked genital papilla. It is oval in shape and is situated posterior to the caecal bifurcation.

The ovary is rounded and smooth. It measures 0.0–0.4. It is situated approximately midway between the hind border of the posterior testis and the anterior border of the acetabulum, but is displaced a little to the right. The oviduct arises from the dorsal aspect of the ovary and pentrates the shell gland. The latter is smaller than the ovary and lies posterior to it. The oviduct and the vitelline duct form an ootype within the shell gland. The uterus emerges from the ootype and runs anteriorly and intracaecally to open into the genital atrium. The eggs in the uterus are oval in shape and operculated. They measure 0.1–0.13 long and 0.04–0.05 broad.

The vitelline glands are in clusters and irregularly lobed. They are extracaecal and extend from just behind the cirrus pouch to just in front of the acetabulum.

The excretory system was not very clear in the stained preparations. Two main excretory trunks lie extra-caecally and extend almost the whole length of the body. The excretory bladder appears to be situated dorsal to the acetabulum. The excretory pore opens on the dorsal surface of the worm approximately in the middle of the acetabular region.

Discussion.—*Q. purvisi* was first also described from the intestine of *Heosemys grandis,* in Kedah, Malaya. The species was originally assigned to the genus *Chiorchis* Fischoeder, 1901 but Skrjabin (1949) transferred it to a new genus, *Quasichiorchis.*

The present material was found to be in general morphological agreement with the original description of the species. In detailed measurements however the two differed considerably. This is perhaps due either to differences in the state of maturity of the worms or their state of preservation.

Notes on infection.—*Q. purvisi* is normally found firmly attached to the stomach wall of the host. In one instance hundreds of the parasite were thus recorded. Large areas of scar tissue as well as fresh wounds were seen on the stomach wall. The scar tissue regions were brown in colour. A study was made of the damage to the stomach wall due to *Q. purvisi* infection.

Tissues from the scar areas as well as fresh wounds were fixed in Bouin. These were sectioned at 5u, and stained with Heidenhein Haematoxylin. In fresh wound sections (i.e., of areas of recent attachment) the gastric mucosa was found to be badly damaged and the villi eroded, while in the scar tissue sections (i.e., of healing tissues) various stages of repair of the stomach wall was observed. The eroded villi were covered over by a fibrous tissue layer. *Q. purvisi* was normally found attached to only non-scar tissue areas of the stomach wall. This may be due to the fact that prolonged settlement of the parasite leads to damage of the stomach wall, and leads to fibrosis resulting in loss of food supply for the parasite. This perhaps induces the worms to migrate to undamaged adjoining areas, whilst the already damaged tissues heal with scar formation.

CESTODA

Only two species of cestodes were recorded namely, *Duthiersia expansa* Perrier and *Bothridium pithonis* Blainville. The record of *D. expansa* is new to Malaya.

Duthiersia expansa Perrier, 1873. (Figure 4).

Material examined.—The present study is based mainly on material collected from the small intestine of *Varanus salvator* (Laur.). In all, eighteen lizards were examined and more than 180 immature and mature *D. expansa* were recovered. About 95% of this material were collected from a single lizard purchased from the Sago Lane market in Chinatown, Singapore on 18.3.1961. In addition to these, it has also been possible to examine material lent by the Zoology Division, Institute for Medical Research, Kuala Lumpur. This material was obtained from the intestine of *Varanus spp.,* trapped in the Bukit Lagong and Ulu Langat Forest Reserves in Selangor, Federation of Malaya, during 1959–1960. The worms collected in Singapore and Malaya were found to be morphologically identical.

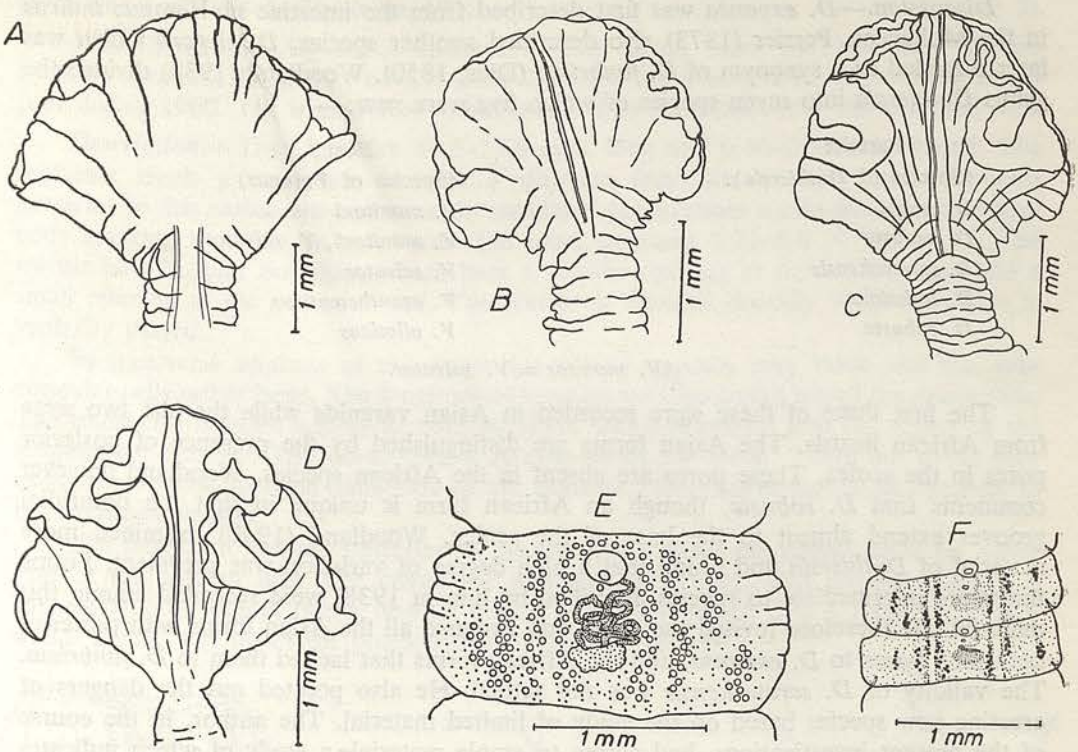

Figure 4. *Duthiersia expansa*. (A)–(D) Scolices. (E) Mature proglottid. (F) Young proglottid.

Description.—They mature 10.8–9.10 long and 0.58–3.16 broad. The worm is broadest at about half the body length. The length of the proglottids in this region of maximum breadth is 0.31–0.64. Just behind this region the proglottids are narrower and longer. A few of the posteriormost segments are very narrow. In mature worms they measure 1.82–2.14 long and 1.41–1.56 broad.

The scolex measures 1.23–2.46 long and 1.77–3.14 broad. It is composed of two bothria, one dorsal and one ventral. These are united in the midline. The scolex shape is very variable. So is the extent of the marginal folds of the bothria. In young specimens the scolex is funnel shaped. The bothrial margins lack any folds. In mature forms the scolex assumes a more or less triangular shape and the bothrial margins are heavily scalloped, and overhang the shallow suckers.

The excretory system consists of two canals (one small and dorsal the other large and ventral) situated on either side near the margin of the medulla. The canals on the same side anastomose freely. A single longitudinal nerve runs along each lateral margin of the worm on the outer side of the excretory canals. Mature proglottids have numerous testes which are also situated in the medulla. They are distributed lateral to the excretory vessels. The vas deferens opens ventrally within the anterior half of the proglottid. The ovary is bilobed and situated in the posterior half of the proglottid. The vagina opens posterior to the vas deferens. Vitelline glands are numerous and well developed. They are situated in the cortex. The uterus is in loops, which are ill-defined, particularly in the more mature segments. The uterine eggs measure 0.030 × 0.045.

Discussion.—D. expansa was first described from the intestine of *Varanus indicus* in the Molluccas. Perrier (1873) also described another species, *D. elegans* which was later regarded as a synonym of *D. fimbriata* (Dies, 1850). Woodland (1938) divided the genus *Duthiersia* into seven species of which five were new:—

Parasite (Species of *Duthiersia*).	Host (Species of *Varanus*)
D. crassa	*V. monitor*‡
D. venusta	*V. monitor*‡, *V. salvator*
D. sarawakensis	*V. salvator*
D. latissima	*V. exanthematicus*
D. robusta	*V. niloticus*

‡*V. monitor* = *V. salvator.*

The first three of these were recorded in Asian varanids while the last two were from African lizards. The Asian forms are distinguished by the presence of posterior pores in the scolex. These pores are absent in the African species. Woodland however comments that *D. robusta,* though an African form is unique in that the bothridial grooves extend almost to the base of the scolex. Woodland (1940) examined more material of *Duthiersia* and found that a high degree of variation was prevalent. Forms that were intermediate to species described by him in 1938, were recorded among this material. He therefore revised the genus and assigned all the Asian forms with posterior bothridial pores to *D. expansa,* and the African forms that lacked them to *D. fimbriata.* The validity of *D. sarawakensis* was not settled. He also pointed out the dangers of erecting new species based on the study of limited material. The author, in the course of the present investigations, had access to ample material, a study of which indicates that *D. sarawakensis* is probably a juvenile form of *D. expansa.*

The present study shows that scolex structure and shape are variable in *D. expansa.* These depend on the state of maturity of the worm. A number of different scolex types, and forms intermediate between them were found among the material examined. A selection of these are shown in Figs. 4A–4D. They represent a series of young to mature forms.

Woodland (1940) claims that in Asiatic forms of *Duthiersia,* strobuli characters do not correspond with scolex characters. This is probably true of measurements of these two body regions of the worms. However there appears to be some relationship between scolex structure and shape and state of maturity of the worm. In immature forms (Fig. 4A) the scolex is normally funnel shaped and the bothrial margins are not thrown into folds. In mature forms (Fig. 4D) the scolex is more or less triangular in shape, and the lateral margins of the bothria are heavily scalloped and overhang the suckers. In worms whose state of maturity is intermediate between these two, scolex character is also intermediate. (Figs. 4B & 4C).

Scolex type (Fig. 4B) was found to be identical with that of *D. sarawakensis* Woodland, 1938. Hence it is probable that *D. sarawakensis* is only a juvenile form of *D. expansa.*

It is interesting to note that Southwell (1930) and Yamaguti (1958) have both cited Asian species of *Varanus* (*V. salvator* and *V. bengalensis*) as hosts for *D. fimbriata.* If this be so then the distinction of *D. fimbriata* as the African form and *D. expansa* as the Asian form may not be valid.

Bothridium pithonis de Blainville, 1824. (Figure 5).

Material examined.—Three specimens were taken from the intestines of two *Python reticulatus* (Schneid.) bought from the Sago Lane market in Chinatown, Singapore during 1960. The worms were found attached by their scolices to the intestinal wall.

Description.—They measure 40.5–75.8 cms. long and 0.46–0.82 cms. broad. The segments reach a maximum breadth ¾ distance from the anterior end. Segments posterior to this region are narrower. In unstained preparations a mid-dorsal and ventral body marking is visible on the worm. The head measures 3.21–6.0 × 2.62–4.12. The worms have tubular bothridia, which bear a slit-like opening at the anterior end and a small opening at the posterior end. The former is situated dorsally while the latter is ventrally placed.

In transverse sections of the worm the cuticle appears very thick and the subcuticular cells rather large. The longitudinal muscles are distributed round the proglottids. The transverse muscles appear to send off fibres which penetrate into the region of the longitudinal muscles. The dorso-ventral muscle bands are small. There are in all four excretory vessels—two on each side of the segment. The lateral nerves lie external to the excretory vessels.

The testes are situated posterior to the cirrus sac along the lateral fields on either side of the median line. The cirrus sac measures 0.24–0.32. The genital opening is superficial. The vagina opens directly behind the cirrus pouch into a common atrium which is half way down the proglottid from the anteroir end.

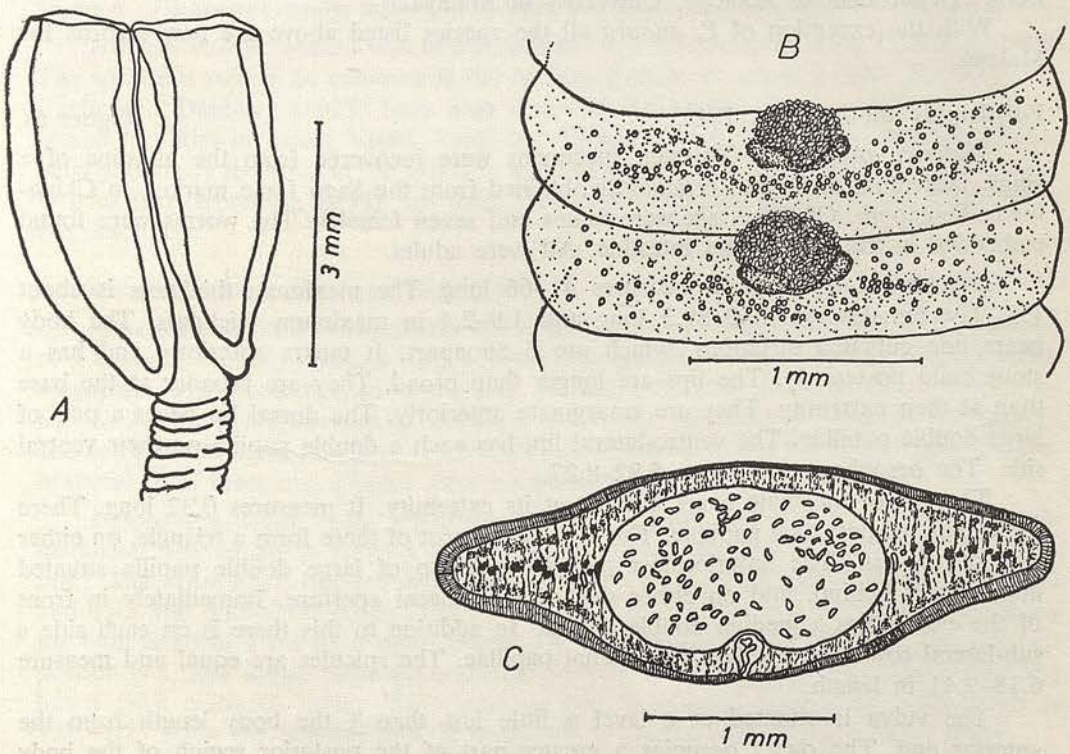

Figure 5. *Bothridium pithonis.* (A) Scolex. (B) Mature proglottid. (C) T.S. of mature proglottid.

The uterine pore is approximately two-third the distance from the anterior end of the proglottid. The genital pores are irregularly alternate. The vagina runs directly posterior to the cirrus sac. The reciptaculum seminalis is thick walled. The ovary is V-shaped. Its apex is directed dorsally. It is surrounded by the testis. A shell gland is present. In moderately mature proglottids the uterus is seen to lie in two loops one on each side of the median line. The eggs measure 64–71u × 43–46u.

Discussion.—*B. pithonis* was first also described from the intestine of *Python reticulatus*. Southwell (1930) records it from *P. reticulatus* in Bengal and from *P. molurus* in Nepal and Ceylon. He also recorded the worm in the intestine of *Felis tigris* in India. It is possible that the tiger is not the natural host of the worm, but acquired it by having eaten a python. More recent records of the parasite include that by Kobayashi & Syogaki (1935) who recorded it from *P. reticulatus* in Japan. The parasite has been previously recorded in Malaya by Loewen (1946) and Yeh (1956) from the intestine of *Naja hannah* (Cant.).

NEMATODA

Seven species of nematodes are described, namely, *Polydelphis anoura* Duj. *Atractis granulosa* (Railliet and Henry), *Cissophyllus laverani* Railliet and Henry, *Falcaustra onama* (Karve), *Strongyluris calotis* Baylis and Daubney, *Abbreviata varani* (Parona) and *Tanqua tiara* (v. Linstow).

They were all collected from reptile hosts in Singapore. In the case of *A. granulosa* and *C. laverani,* however, a study was also made of specimens kindly lent by Dr. A. J. Berry, Department of Zoology, University of Malaya.

With the exception of *P. anoura* all the species listed above are new records for Malaya.

Polydelphis anoura Duj., 1845. (Figure 6).

Material examined.—Thirteen specimens were recovered from the intestine of a single individual of *Python reticulatus* obtained from the Sago Lane market, in Chinatown, Singapore. Of these, six were males and seven females. The worms were found embedded in the wall of the intestine. All were adults.

Description.—The male measures 41–66 long. The maximum thickness is about 1.6. The females are 69.3–89.2 long and 1.9–2.4 in maximum thickness. The body bears fine cuticular striations, which are 5–8u apart. It tapers anteriorly and has a stout build posteriorly. The lips are longer than broad. They are broader at the base than at their extremity. They are emarginate anteriorly. The dorsal lip bears a pair of large double papillae. The ventro-lateral lip, has each a double papilla on their ventral side. The oesophagus measures 5.82–8.27.

The tail of the male bears a spike at its extremity. It measures 0.32 long. There are 6 pairs of post anal papillae. The 3 posteriormost of these form a triangle, on either side of the tail. The anteriormost pair is made up of large double papilla situated immediately behind, and on either side of the cloacal aperture. Immediately in front of the cloaca lies a median double papilla. In addition to this there is on each side a sub-lateral row of more than 25 preanal papillae. The spicules are equal and measure 6.18–9.41 in length.

The vulva is situated at a level a little less than $\frac{1}{3}$ the body length from the anterior end. The ovary occupies a greater part of the posterior region of the body between the vulva and the anus. Eggs are spherical and measure 0.05–0.06 in diameter.

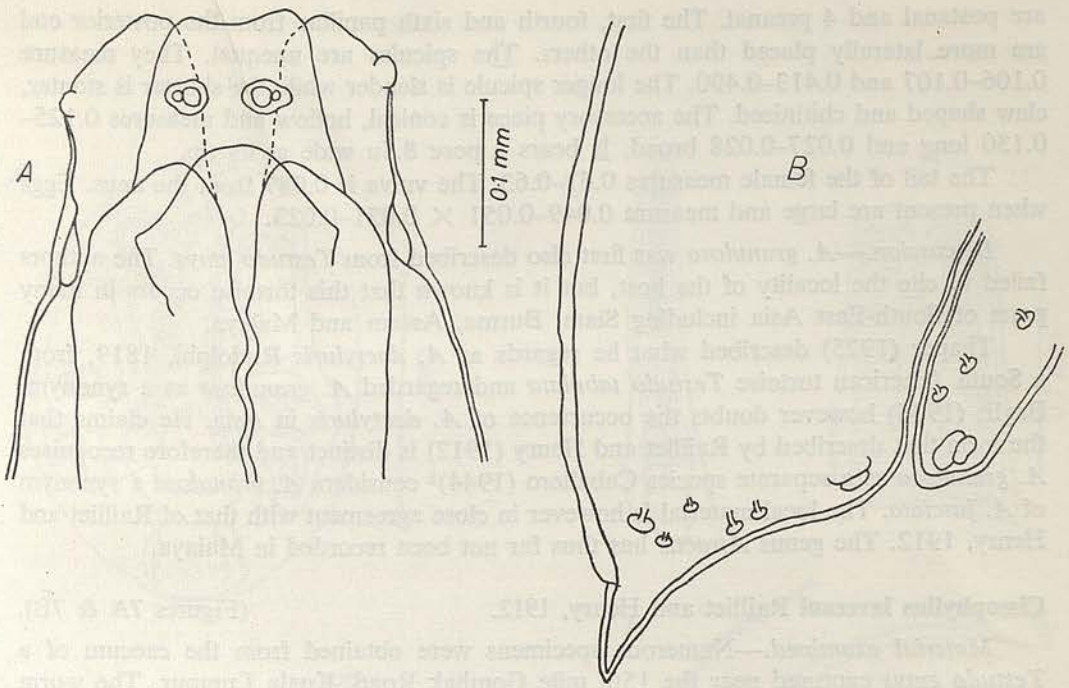

Figure 6. *Polydelphis anoura,* male. (A) Anterior end, dorsal view. (B) Posterior end, lateral view.

Discussion.—*P. anoura* was first described from the Indian python, *Python molurus.* The species is said to be common in the African python, *P. sebae,* as well (Baylis 1936). Baylis and Daubney (1923) have also recorded the species in *P. molurus* in various Indian localities including Nepal, Terai and Kichna, Naini-Tal district. The species has been previously recorded in the stomach and oesophagus of a local python, *P. reticulatus,* in Alor Star (Robinson 1934), but these specimens were immature and the worms were not described.

Atractis granulosa Railliet and Henry, 1912. (Figures 7C, 7D & 7E).

Material examined.—Numerous specimens were obtained from the large intestine of a tortoise, *Testudo emys* (Schleg. & Mull.), caught in the Nee Soon Catchment Area, Singapore. The worm burden was heavy. In addition, some material was collected by Dr. A. J. Berry, Department of Zoology, University of Malaya, from the intestine of another *Testudo emys* caught near the 15th mile Gombak Road, Kuala Lumpur, Malaya. Material from these two sources were morphologically identical.

Description.—The male measures 4.68–5.21 long and 0.20–0.22 in maximum thickness. The female is 5.1–5.8 and 0.32–0.34 thick. The cuticle bears very fine striations. The worm has 6 lips and each bears a papilla. The oesophagus measures 0.78–0.86 and 0.85 and 0.85–0.96 in the male and female respectively. The oesophagus including the bulb is about $\frac{1}{6}$ the total body length. The oesophagus is in two parts. The anterior portion is a little longer than the posterior portion. It is hexagonal in cross-section and has a thick chitinous lining. The excretory pore is situated behind the oesophagus at 1.01–1.17 from the anterior end. It leads into a bladder with thick striated walls.

The posterior region of the male is curved. The tail measures 0.85–0.88. The lips of the cloacal aperture are prominent. There are ten pairs of caudal papillae of which 6

are postanal and 4 preanal. The first, fourth and sixth papillae from the posterior end are more laterally placed than the others. The spicules are unequal. They measure 0.106–0.107 and 0.413–0.490. The longer spicule is slender while the shorter is stouter, claw shaped and chitinized. The accessory piece is conical, hollow and measures 0.125–0.130 long and 0.027–0.028 broad. It bears a pore 8.5u wide at its tip.

The tail of the female measures 0.61–0.63. The vulva is 0.087 from the anus. Eggs when present are large and measure 0.049–0.051 × 0.021–0.023.

Discussion.—A. granulosa was first also described from *Testudo emys*. The authors failed to cite the locality of the host, but it is known that this tortoise occurs in many parts of South-East Asia including Siam, Burma, Assam and Malaya.

Thaper (1925) described what he regards as *A. dactyluris* Rudolphi, 1819, from a South American tortoise *Testudo tabulata* and regarded *A. granulosa* as a synonym. Baylis (1936) however doubts the occurrence of *A. dactyluris* in Asia. He claims that the form first described by Railliet and Henry (1912) is distinct and therefore recognises *A. granulosa* as a separate species Ćaballero (1944)[3] considers *A. granulosa* a synonym of *A. fasciata*. The local material is however in close agreement with that of Railliet and Henry, 1912. The genus *Atractis* has thus far not been recorded in Malaya.

Cissophyllus laverani Railliet and Henry, 1912. (Figures 7A & 7B).

Material examined.—Numerous specimens were obtained from the caecum of a *Testudo emys* captured near the 15th mile Gombak Road, Kuala Lumpur. The worm burden was heavy and a mixed infection of the host was observed (*C. laverani* and *A. granulosa*). The worms were found lying freely, mixed with the gut contents but unattached to the walls of the intestine.

Description.—The male measures 24.23–31.61 long and 1.44–1.63 in maximum thickness, the female 24.01–31.24 and 1.53–1.81 respectively. The cuticular striations on the body are very fine (30u apart). The intervals between them tend to increase in the head region (80u apart). The cephalic papillae end in double terminations. The oesophagus is 3.71–3.83 long. It is composed of three portions. The anteriormost two of these are of equal length and longer than the remaining third portion. Of these three portions, the middle one appears most chitinized. The oesophagus terminates posteriorly in globular bulb containing finely folded chitinous plates.

The tail of the male is 0.42–0.49 long. The 'sucker' is 1.8–2.1 from the cloaca. There are eleven pairs of caudal papillae. Of these six are preanal and five postanal. The three anterior-most of the preanals appear to be equidistant from one another. The remaining three are close to one another and situated in front of the anus. Of the post anal papillae, the first pair is just behind the anus. It is remote from the remaining four. The spicules are sub-equal, forked and measure 1.92–2.21. The right spicule is longer than the left, the difference between the two being 0.12–0.15. The accessory piece is hollow and measures 0.48–0.51 long and 0.18–0.21 broad. The tail of the female is 0.91–1.11 long and bears a pair of papillae. The vulva is a little behind the posterior third of the body. The eggs are oblong with very thin shells and measure 0.12–0.19 × 0.068–0.075.

[3] Only abstract seen.

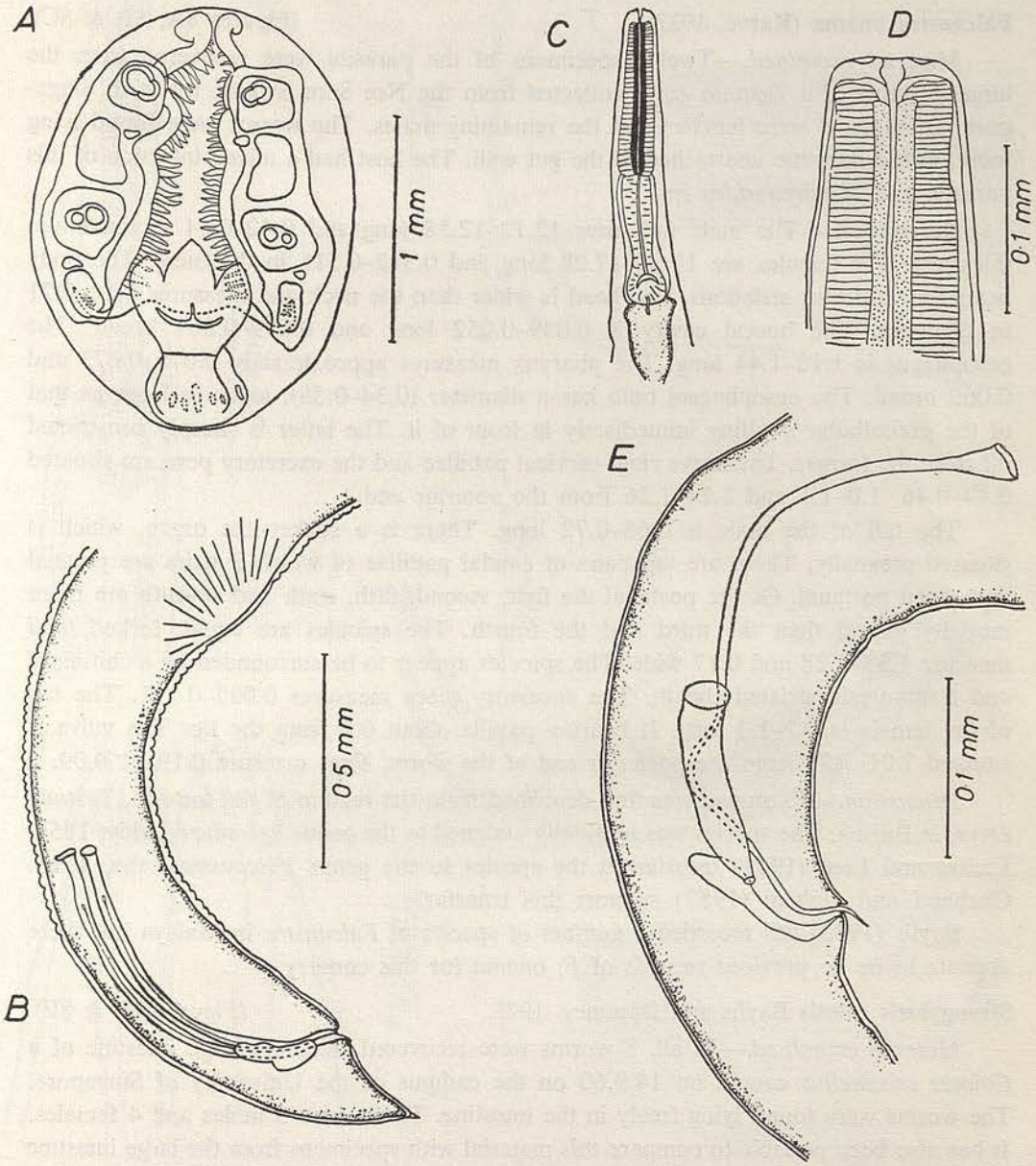

Figure 7. (A) & (B) *Cissophyllus laverani*. (A) En face view. (B) Posterior end of male. (C)–(E) *Atractis granulosa*. (C) & (D) Anterior end, lateral view. (E) Posterior end of male, lateral view.

Discussion.—*C. laverani* was first also described from the intestine of the tortoise, *Testudo emys*. The authors did not give the locality of the host, but this tortoise is widely distributed in S.E. Asia, occurring in Burma, Assam, Siam, Malaya and Indonesia. There appears to be no record of the parasite, subsequent to this.

Falcaustra onama (Karve, 1927). (Figures 8A, 8B & 8C).

Material examined.—Twelve specimens of the parasite were recovered from the large intestine of a *Testudo emys* collected from the Nee Soon swamp forest in Singapore. Of these, 8 were females and the remaining males. The worms were found lying loose, in the intestine unattached to the gut wall. The host had a mixed infection of this parasite and *Monhysterides sp.*

Description.—The male measures 12.12–12.58 long and 0.42–0.44 in maximum thickness. The females are 17.04–17.28 long and 0.512–0.518 in thickness. The body bears fine cuticular striations. The head is wider than the neck and measures 0.18–0.21 in diameter. The buccal cavity is 0.049–0.052 long and 0.059–0.061 broad. The oesophagus is 1.18–1.44 long. The pharynx measures approximately 0.071–0.073 and 0.060 broad. The oesophagael bulb has a diameter (0.34–0.38), twice as large as that of the prebulbular swelling immediately in front of it. The latter is sharply constricted off from the former. The nerve ring, cervical papillae and the excretory pore are situated 0.44–0.46, 1.0–1.1 and 1.24–1.26 from the anterior end.

The tail of the male is 0.68–0.72 long. There is a sucker-like organ, which is situated preanally. There are ten pairs of caudal papillae of which 3 pairs are preanal and seven postanal. Of the postanal the first, second, fifth, sixth and seventh are more mesially placed than the third and the fourth. The spicules are equal, forked, and measure 1.35–1.38 and 0.17 wide. The spicules appear to be surrounded by a chitinised and transversely striated sheath. The accessory piece measures 0.097–0.111. The tail of the female is 1.2–1.3 long. It bears a papilla about 0.8 from the tip. The vulva is situated 7.01–7.23 from the posterior end of the worm. Eggs measure 0.19 × 0.09.

Discussion.—*F. onama* was first described from the rectum of the tortoise, *Testudo emys,* in Burma. The species was originally assigned to the genus *Spironura* Leidy, 1856. Freitas and Lent (1941) transferred the species to the genus *Falcaustra* Lane, 1915. Chabaud and Golvan (1957) support this transfer.

Baylis (1933) has recorded a number of species of *Falcaustra* in Malaya but there appears to be no previous records of *F. onama* for this country.

Strongyluris calotis Baylis and Daubney, 1923. (Figures 8D & 8E).

Material examined.—In all, 8 worms were recovered from the large intestine of a *Calotes cristatellus* caught on 14.9.60 on the campus of the University of Singapore. The worms were found lying freely in the intestine. There were 3 males and 4 females. It has also been possible to compare this material with specimens from the large intestine of a *Gonocephalus grandis* (Gray) trapped in the Bukit Lagong Forest Reserve, Selangor, Federation of Malaya (Helminth Collections, in the Department of Parasitology, University of Singapore). The specimens from the two sources were morphologically identical.

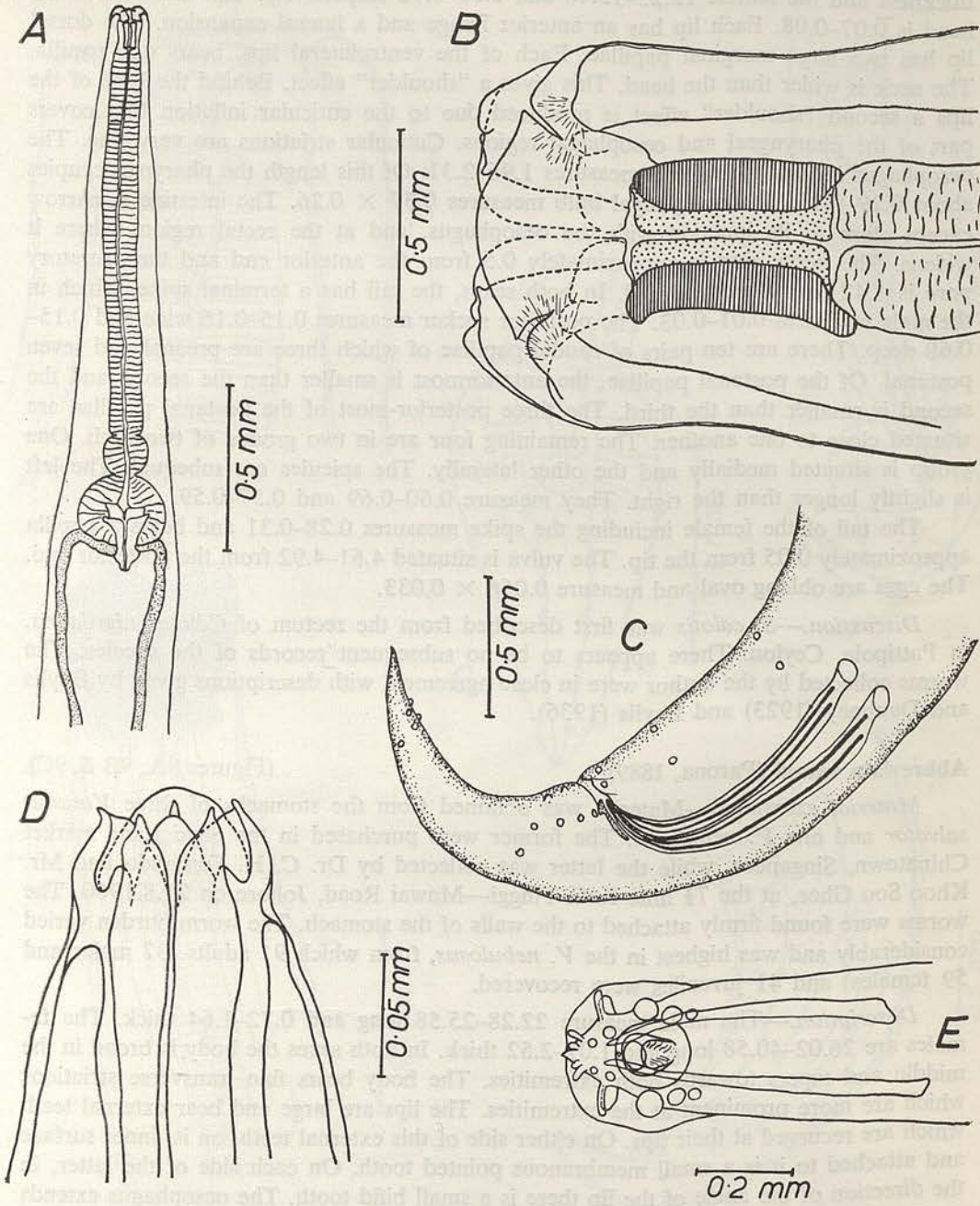

Figure 8. (A)–(C) *Falcaustra onama*. (A) & (B) Anterior end of male, dorsal view. (C) Posterior end of male. (D) & (E) *Strongyluris calotis*. (D) Anterior end of male, ventral view. (E) posterior end of male, ventral view.

Description.—The male measures 9.41–10.23 in length and 0.47–0.52 in maximum thickness and the female 12.23–13.48 and 0.51–0.76 respectively. The diameter of the head is 0.07–0.08. Each lip has an anterior flange and a lateral expansion. The dorsal lip has two large marginal papillae. Each of the ventrolateral lips, bears one papilla. The neck is wider than the head. This gives a "shoulder" effect. Behind the base of the lips a second "shoulder" effect is produced due to the cuticular inflation that covers part of the pharyngeal and oesophagal regions. Cuticular striations are very fine. The oesophagus including the bulb measures 1.96–2.31. Of this length the pharynx occupies about 0.29–0.36. The oesophagal bulb measures 0.37 × 0.26. The intestine is narrow except close to its junction with the oesophagus, and at the rectal region, where it widens. The nerve ring is approximately 0.5 from the anterior end and the excretory pore is 1.42 from the same end. In both sexes, the tail has a terminal spike, which in the male measures 0.01–0.03. The posterior sucker measures 0.15–0.16 wide and 0.15–0.68 deep. There are ten pairs of caudal papillae of which three are preanal and seven postanal. Of the postanal papillae, the anteriormost is smaller than the second and the second is smaller than the third. The three posterior-most of the postanal papillae are situated close to one another. The remaining four are in two groups of two each. One group is situated medially and the other laterally. The spicules are subequal. The left is slightly longer than the right. They measure 0.60–0.69 and 0.57–0.59.

The tail of the female including the spike measures 0.28–0.31 and bears a papilla approximately 0.05 from the tip. The vulva is situated 4.61–4.92 from the posterior end. The eggs are oblong oval and measure 0.066 × 0.033.

Discussion.—*S. calotis* was first described from the rectum of *Calotes nigrilabris,* in Pattipola, Ceylon. There appears to be no subsequent records of the species. The worms collected by the author were in close agreement with descriptions given by Baylis and Daubney (1923) and Baylis (1936).

Abbreviata varani (Parona, 1889). (Figures 9A, 9B & 9C).

Material examined.—Material was obtained from the stomachs of three *Varanus salvator* and one *V. nebulosus*. The former were purchased in the Sago Lane market Chinatown, Singapore, while the latter was collected by Dr. C. H. Fernando and Mr. Khoo Soo Ghee, at the 7½ mile Kota Tinggi—Mawai Road, Johore on 21.8.1960. The worms were found firmly attached to the walls of the stomach. The worm burden varied considerably and was highest in the *V. nebulosus,* from which 91 adults (32 males and 59 females) and 41 juveniles were recovered.

Description.—The male measure 22.28–25.58 long and 0.72–1.64 thick. The females are 26.02–40.58 long and 1.07–2.52 thick. In both sexes the body is broad in the middle and tapers towards both extremities. The body bears fine transverse striations which are more prominent at the extremities. The lips are large and bear external teeth which are recurved at their tips. On either side of this external teeth, on its inner surface and attached to it is a small membranous pointed tooth. On each side of the latter, in the direction of the angle of the lip there is a small bifid tooth. The oesophagus extends to about $\frac{1}{6}$ the length of the worm, and is divided into two portions. The nerve ring is situated anterior, and the excretory pore and cervical papillae posterior to the junction of these two portions of the oesophagus.

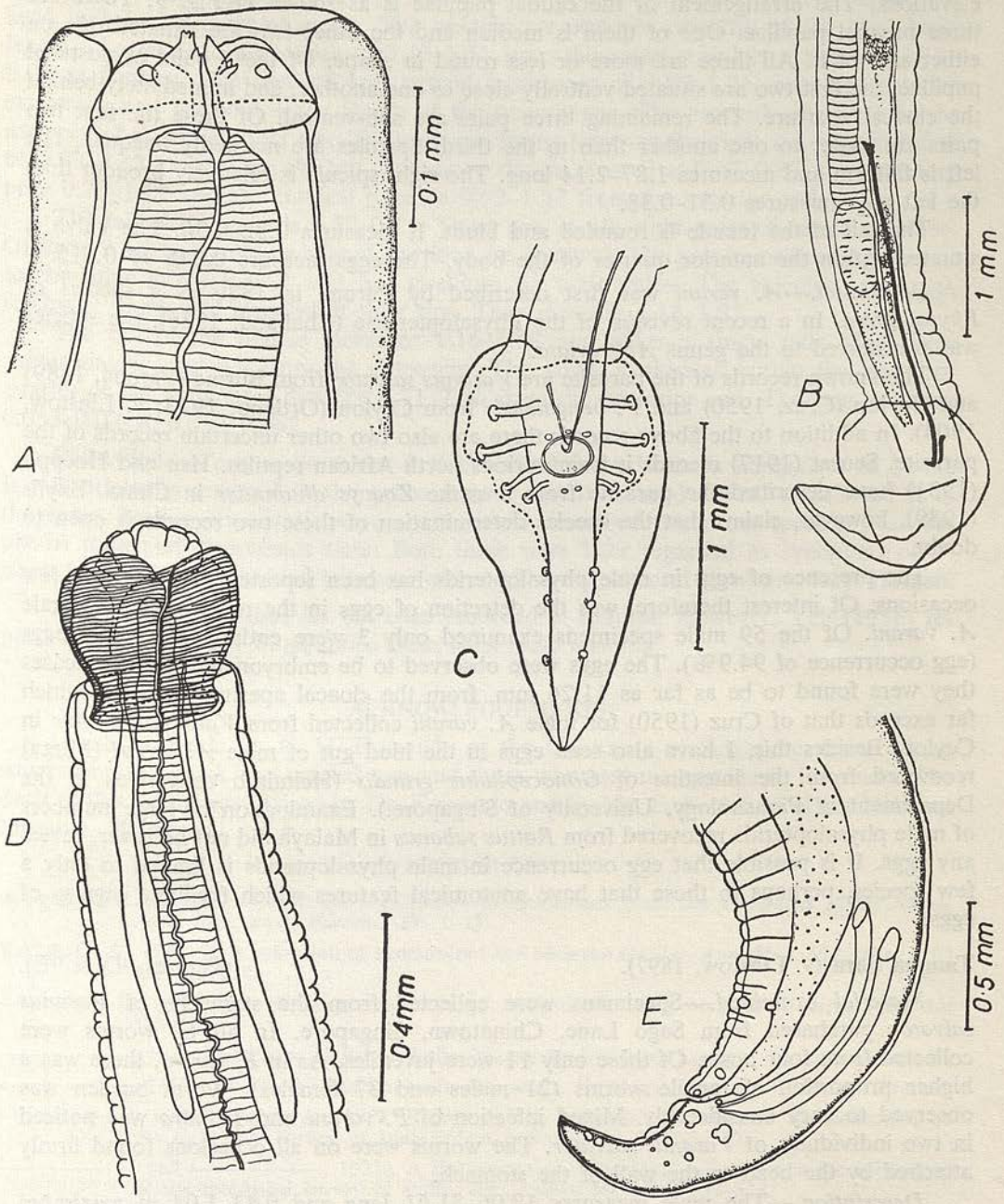

Figure 9. (A)–(C) *Abbreviata varani*. (A) Anterior end, ventral view. (B) Lateral and (C) Ventral view of posterior end of male. (D) & (E) *Tanqua tiara*. (D) Anterior end, dorso-lateral view. (E) Posterior end of male.

The caudal bursa of the male is about twice as long as it is broad. The tail of the male measures 1.42–1.46. The ventral surface of the cloacal region bears cuticular elevations. The arrangement of the caudal papillae is as shown in Fig. 9. There are three preanal papillae. One of them is median and the other two are situated one on either side of it. All three are more or less round in shape. Of the 5 pairs of postanal papillae, the first two are situated ventrally close to one another, and immediately behind the cloacal aperture. The remaining three pairs are sub-ventral. Of these the first two pairs are closer to one another than to the third. Spicules are markedly unequal. The left is filiform and measures 1.87–2.14 long. The right spicule is relatively broader than the left and measures 0.31–0.38.

The tail of the female is rounded and blunt. It measures 0.32–0.36. The vulva is situated within the anterior quarter of the body. The eggs measure 0.045 × 0.015.

Discussion.—A. varani was first described by Parona in 1889 as a species of *Physaloptera.* In a recent revision of the Physalopterinae (Chaband, 1956), the species was transferred to the genus *Abbreviata.*

The known records of the parasite are *Varanus salvator* from Burma (Parona, 1889) and Ceylon (Cruz, 1950) and *V. bengalensis* from Ceylon (Ortlepp, 1923; v. Linstow, 1904). In addition to the above records there are also two other uncertain records of the parasite. Seurat (1917) records it from various north African reptiles. Hsu and Hoeppli (1931) have described the parasite from a snake *Zoacys dhumndes* in China. Baylis (1939), however, claims that the species determination of these two records is open to doubt.

The presence of eggs in male physalopterids has been reported only on very few occasions. Of interest therefore, was the detection of eggs in the rectal region of male *A. varani.* Of the 59 male specimens examined only 3 were entirely lacking in eggs (egg occurrence of 94.9%). The eggs were observed to be embryonated. In some cases they were found to be as far as 11.26 mm. from the cloacal aperture, a figure which far exceeds that of Cruz (1950) for male *A. varani* collected from *Varanus monitor* in Ceylon. Besides this, I have also seen eggs in the hind gut of male *A. achari* (Mirza) recovered from the intestine of *Gonocephalus grandis* (Helminth collections in the Department of Parasitology, University of Singapore.). Examination of large numbers of male physalopterids recovered from *Rattus sabanas* in Malayā did not however, reveal any eggs. It is possible that egg occurrence in male physalopterids is limited to only a few species, perhaps to those that have anatomical features which facilitate ingress of eggs.

Tanqua tiara (v. Linstow, 1897). (Figures 9D & 9E).

Material examined.—Specimens were collected from the stomachs of *Varanus salvator* purchased from Sago Lane, Chinatown, Singapore. In all 69 worms were collected from four hosts. Of these only 11 were juveniles. As in *P. varani,* there was a higher proportion of female worms (21 males and 37 females). Worm burden was observed to vary considerably. Mixed infection of *P. varani* and *T. tiara* was noticed in two individuals of *Varanus salvator.* The worms were on all occasions found firmly attached by the head to the wall of the stomach.

Description.—The male measures 17.06–31.61 long and 0.43–1.04 in maximum thickness, the female 21.23–45.46 long and 0.72–1.51 thick. The cuticular striations on the body are between 32–48u. The head bulb has a transverse diameter of 0.31–0.56. In mature specimens it is divided by longitudinal grooves into four lobes. In immature

specimens only two lobes are noticeable. The transverse striations on the head bulb are 6–9u apart. Lips are flattened in front and their inner surface is ridged (five ridges). The ridges of one lip interlock with those of the opposite lip. Immediately behind the head bulb is a prominent collar. The oesophagus occupies one-fifth of the total body length. It extends to a distance of 3.42–6.51 from the anterior end in males and 4.18–9.02 in females. The cervical sacs extend a distance of 1.05–1.26 from the anterior extremity, and is about ¼ the length of the oesophagus. The cervical sacs were in the majority of cases of equal size. In some specimens however the right sac was found to be 0.08–0.12 longer than the left. The nerve ring is situated at 0.62–0.87, the excretory pore 0.79–1.21 and the cervical papillae 0.92–1.37 from the anterior end.

The tail of the male is 0.52–0.71. There are, in all, eight pairs of caudal papillae. Of these 3 are preanal, one adanal and four are postanal. The pair immediately posterior to the anus is the largest and has swellings on their pulps. The spicules are equal, relatively small, and rounded at their tips. They measure 1.14–1.81.

The tail of the female measures 1.16–1.68 and bears a single pair of papillae subterminally, and 0.9 from the extremity. The vulva is situated within the posterior quarter of the body, at a distance 4.71–7.96 from the posterior end. The eggs measure 0.053–0.07 × 0.034–0.048.

Discussion.—Tanqua tiara was first described from *Varanus albigularis* in Natal. It was originally assigned to the genus *Ascaris* but Blanchard (1904) transferred it to the genus *Tanqua*. In the same year v. Linstow described two other species, *Ctenocephalus tiara* and *Tetradenos tiara*. Both these were later regarded as synonyms of *T. tiara*. Schad (1959) recorded it from *Varanus dumerili* taken at Dewhurst Bay, Borneo.

Tanqua tiara has thus far not been recorded in Malaya. However, Yeh (1956) reports a related species *T. gigantica* from local *Naja hannah*.

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Notes on a re-examination of some Bleeker type specimens of Indo-Malayan fresh-water fishes. Part 2. Abramidinae and Rasborinae

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INTRODUCTION

SINCE THE PUBLICATION of the first paper in this series (1961), some valuable information on the Bleeker type specimens has been given by Mees (1962, pp. 80–82). There is now little doubt that by far the most important part of the Bleeker collections is in the Rijksmuseum van Natuurlijke Historie in Leiden.

As in the previous paper, the type specimens are listed below under the generic and the specific names that they were first described. The original publication is cited in each case and this is followed on the next line, where necessary, by the synonym I have accepted. Lectotypes and Paratypes are herein designated for the first time. The measurements and counts of the Lectotypes or Holotypes are given first. The figures in brackets refer to the Paratypes. The following abbreviations are used:— ZMA = Zoologisch Museum, Amsterdam; BM = British Museum (Natural History), London; ML = Rijksmuseum van Natuurlijke Historie, Leiden.

I have not been able to locate the types of some of the Rasborinae. Of these, the types of *Barbus podonemus* (1850) and *Leuciscus einthovenii* (1851) are not included in the collections in Leiden, London and Amsterdam. The types of *Leuciscus argyrotaenia* (1850), *L. cyanotaenia* (1850) and *L. schwenkii* (1858) are, however, probably mixed within the large Bleeker series of *Rasbora argyrotaenia* (Bleeker) in Leiden.

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Subfamily ABRAMIDINAE

Chela hypophthalmus Bleeker.

Act. Soc. Sci. Indo-Neerl., 1860, vol. 7, p. 471.

LECTOTYPE: ML 4985, Palembang, Sumatra.

PARATYPE: BM 1866.5.2.218, same data.

Dorsal ii.7 (iii.7); anal iii.29 (iii.29); pectoral i.12 (i.12); ventral i.6 (i.7). Caudal fins damaged; total length according to Bleeker, 155 & 165 mm.; standard length 118.5 mm. (130.0 mm.); depth 3.3 (3.0); head 4.6 (4.8); eye (3.0); snout (3.4). Lateral line 59 (56); transverse scales 12/1/8 (11½/1/7); caudal peduncular scales 6/1/4. Pectoral fins reaching anus.

A silvery stripe from the upper corner of the opercle to the caudal base.

Leuciscus helfrichii Bleeker.

Act. Soc. Sci. Indo-Neerl., 1857, vol. 2, p. 15.

=*Rasborichthys helfrichii* (Bleeker).
LECTOTYPE: BM 1866.5.2.162, River Kahajan, Borneo, C. Helfrich.
PARATYPE: ML 4970, same data.

Dorsal ii.7 (ii.7); anal iii.19 (iii.18); pectoral ii.15 (ii.14); ventral ii.8 (ii.8). Total length 90.0 mm. (116.0 mm.); standard length 74.0 mm. (90.7 mm.); depth 4.5 (4.7); head 4.1 (4.4); eye 3.0 (3.5); snout 4.0 (3.9). Lateral line 61 (57); transverse scales $10\frac{1}{2}/1/6\frac{1}{2}$ ($10/1/7\frac{1}{2}$); caudal peduncular scales $8\frac{1}{2}/1/6$ ($8/1/5\frac{1}{2}$).
More or less uniform silvery brown.

Leuciscus oxygastroides Bleeker.

Nat. Tijdschr. Ned. Indie, 1852, vol. 3, p. 431.

=*Chela oxygastroides* (Bleeker).
LECTOTYPE: BM 1866.5.2.216, River Kusan, Prabukarta, Borneo, J. H. Croockewit, *or* River Mussi, Palembang, Sumatra, J. M. van Leer *or* Batavia, Java, P. Bleeker.
PARATYPES (5): ML 4984, same data.
(1): ML 8062, same data.

The specimens have been mixed and I have no way of separating them by locality. The lectotype is also the holotype of *C. megalolepis* Gunther.
Dorsal ii.7 (ii.7); anal iii.28 (iii.23–29); pectoral i.12 (i.11–i.13); ventral i.6 (i.6). Total length 123.0 mm. (44.5–143.0 mm.); standard length 100.0 mm. (36.4–117.6 mm.); depth 3.6 (3.1–3.6); head 4.4 (4.1–4.7); eye 3.0; snout 3.8. Most scale counts not possible. In ML 8062, lateral line 39, transverse scales 10/1/6, caudal peduncular scales 6/1/2. Pectoral fins not reaching anus.
A mid-lateral silvery stripe from the head to the caudal base.

Leuciscus uranoscopus Bleeker.

Nat. Tijdschr. Ned. Indie, 1851, vol. 1, p. 14.

=*Macrochirichthys macrochirus* (Valenciennes).
HOLOTYPE: ML 7494, Banjermassin, Borneo, J. Wolff.

Dorsal iii.7; anal iii.24; pectoral i.16; ventral i.7. Total length 324.0 mm.; standard length 270.0 mm.; depth 5.1; head 5.3; eye 4.6; snout 3.4. Lateral line 106; other scale counts not possible.
More or less silvery yellow with a dark spot on the caudal base.

Subfamily RASBORINAE

Leuciscus bankanensis Bleeker.

Nat. Tijdschr. Ned. Indie, 1853, vol. 5, p. 192.

=*Rasbora bankanensis* (Bleeker).
HOLOTYPE: BM 1866.5.2.160, Marawang, Banka, H.L. van Bloemen Waanders.

Dorsal ii.7; anal iii.5; pectoral i.14; ventral i.7. Total length about 64.0 mm.; standard length 46.0 mm.; depth 3.6; head 3.5; eye 3.1; snout 3.3. Lateral line (partly estimated) 24; count not possible for transverse scales; predorsals (partly estimated) 10; caudal peduncular scales $3\frac{1}{2}/1/1\frac{1}{2}$. Dorso-hypural distance, carried forwards, falling on posterior orbital rim. Dorsal origin behind base of ventrals.

A pronounced supra-anal stripe, continued backwards along the caudal peduncle. The distal half of the 3rd—5th anal rays with a pronounced black patch.

Leuciscus cephalotaenia Bleeker.

Nat. Tijdschr. Ned. Indie, 1852, vol. 3, p. 97.

=*Rasbora cephalotaenia* (Bleeker).

LECTOTYPE: BM 1866.5.2.151, River Tjirutjup, Biliton, C. de Groot.

PARATYPES (5): ML 4982, same data.

Dorsal ii.7 (ii.7–iii.7); anal iii.5 (iii.5); pectoral i.15 (i.13–i.14) ventral i.9 (i.8). Caudal fins damaged; total length according to Bleeker 85–103 mm.; standard length 65.0 mm. (65.6–75.5 mm.); depth 4.0 (3.6–4.2); head 4.0 (3.5–3.6); eye 3.6 (3.7–4.1); snout 3.3 (3.0–3.2). Lateral line 30 (28–31); transverse scales $5\frac{1}{2}/1/3\frac{1}{2}$; predorsals 12 (11–12); caudal peduncular scales $3\frac{1}{2}/1/1\frac{1}{2}$ ($3\frac{1}{2}/1/1\frac{1}{2}$). Dorso-hypural distance, carried forwards, falling on or between anterior orbital rim and centre of pupil. In the Lectotype the dorsal origin is opposite the 10th scale of the lateral line; the ventral is opposite the 9th and the anal opposite the 17th.

A dark stripe from the tip of the lower jaw to the edge of the opercle, continued as two rows of spots to the caudal base where there is a large spot, thence continued backwards as a weak stripe to the edge of the caudal.

Leuciscus dusonensis Bleeker.

Nat. Tijdschr. Ned. Indie, 1851, vol. 1, p. 14.

=*Rasbora dusonensis* (Bleeker).

HOLOTYPE: ML 7037, River Banjer or River Duson, Banjermassin, Borneo, J. Wolff.

Dorsal ii.7; anal iii.5; pectoral i.15; ventral i.8. Total length 114 mm.; standard length 89.2 mm.; depth 3.8; head 4.0; eye 4.3; snout 3.4. Lateral line (partly estimated) 27; count not possible for transverse scales; predorsals 12; caudal peduncular scales $4\frac{1}{2}/1/1\frac{1}{2}$. Dorso-hypural distance, carried forwards, falling opposite centre of pupil.

The specimen is in poor condition. Only a weak reticulate colouration is visible.

Leuciscus kalochroma Bleeker.

Nat. Tijdschr. Ned. Indie, 1851, vol. 1, p. 272.

=*Rasbora kalochroma* (Bleeker).

LECTOTYPE: ML 4983, River Banjer or River Duson, Banjermassin, Borneo, J. Wolff.

PARATYPES (5): ML 9045, same data.

(1): BM 1866.5.2.156, same data.

Dorsal ii.7 (ii.7); anal iii.5 (iii.5); pectoral i.13 (i.12–i.13); ventral i.7 (i.7). Caudal fins damaged; total length according to Bleeker, 62–85 mm.; standard length 64.5 mm. (53.6–66.2 mm.); depth 3.9 (3.7–4.1); head 3.9 (3.7–4.1); eye 3.9 (3.3–4.9); snout 3.4 (3.3–4.6). The specimens are in poor condition and the scale counts are partly estimated. Lateral line 26 (25–27); transverse scales 4½/1/2½ (4½/1/2½); predorsals 12 (11–12); caudal peduncular scales 3½/1/2½ (3½/1/2½). Dorso-hypural distance, carried forwards, falling between anterior orbital rim and centre of pupil.

The distinctive body markings as originally described, are still clearly seen.

Leuciscus lateristriatus Bleeker.

Nat. Tijdschr. Ned. Indie, 1854, vol. 7, p. 94, p.p.

=*Rasbora lateristriata* (Bleeker).

LECTOTYPE: ML 4969, Batavia, Tandjongoost, Tjampea, Bandong and Garut, Java.

PARATYPES (3): ML 9098, same data.

(1): ZMA 103232, same data.

(3): ML 17486, Lake Meninju, Pajacombo and Telok Betong, Sumatra.

(1): BM 1866.5.2.163, same data.

Although the species was originally described from both Java and Sumatra, Brittan (1954, p. 37) was able to assign to this species specimens from only Java. It is of interest therefore that the type series I have examined consists partly of *R. lateristriata* and partly of *R. sumatrana* (Bleeker). Unfortunately, the specimens are all mixed and none have precise locality labels. I have, however, provisionally assigned the specimens of *sumatrana* to the Sumatran type localities and the *lateristriata* to the localities in Java. The following description is of the first 5 specimens listed above.

Dorsal ii.7 (ii.7); anal iii.5 (iii.5); pectoral i.13 (i.12–i.13); ventral i.8 (i7–i.8). Total length 60.0 mm. (60.5–77.2 mm.); standard length 43.4 mm. (45.6–57.8 mm.); depth 3.8 (3.8–4.3); head 4.1 (3.7–4.0); eye 3.0 (3.7–4.8); snout 3.3 (3.5–3.7). Lateral line 27 (27–28); transverse scales 4½/1/2½ (4½/1/2½); predorsals 13 (12–13); caudal peduncular scales 3½/1/1½ (3½/1/1½). Dorso-hypural distance, carried forwards, falling on pupil.

A silvery-leaden lateral stripe mainly on the 3rd transverse scale row, running from slightly behind the head to the caudal base where it widens. Overlying this stripe is a dark lateral stripe running from the snout to the caudal base where it ends in a dark spot. A distinct oval supra-anal spot. Margins of dorsal, anal and caudal, black.

Leuciscus leptosoma Bleeker.

Nat. Tijdschr. Ned. Indie, 1855, vol. 9, p. 269.

=*Rasbora leptosoma* (Bleeker).

LECTOTYPE: ML 4981, Lahat, Sumatra, P.L. van Bloemen Waanders.

PARATYPE: BM 1866.5.2.157, same data.

Dorsal ii.7 (ii.7); anal iii.5 (iii.5); pectoral i.12 (i.14); ventral i.7 (i.7). Total length 91.5 mm. (64 mm.); standard length 65.4 mm. (47.9 mm.); depth 4.2 (4.2); head 3.9 (4.3); eye 4.2 (3.5); snout 3.7 (3.4). Lateral line 25 (estimated 25); predorsals 10 (10); caudal peduncular scales 3½/1/1½ (3½/1/1½). Dorso-hypural distance, carried forwards, falling between eye and nostril.

Colouration, as originally described.

Leuciscus sumatranus Bleeker.

Nat. Tijdschr. Ned. Indie, 1852, vol. 3, p. 601.

=*Rasbora sumatrana* (Bleeker).
LECTOTYPE: ML 7038, Solok, Sumatra, H. W. Schwanefeld.
PARATYPES (1): ML 8909, same data.
(1): BM 1866.5.2.161, same data.

Dorsal ii.7 (ii.7), anal iii.5 (iii.5); pectoral i.13 (i.14 & i.13); ventral i.8 (i.8 & i.7). Caudal fins damaged; total length according to Bleeker, 85–115 mm.; standard length 77.0 mm. (68.1 & 61.4 mm.); depth 3.9 (3.9 & 3.7); head 3.6 (3.5 & 3.4); eye 3.8 (3.5 & 3.4); snout 3.3 (3.1). Lateral line 23 (22 & 23); transverse scales $4\frac{1}{2}/1/2\frac{1}{2}$ ($4\frac{1}{2}/1/2\frac{1}{2}$); predorsals 10 (11 & 10); caudal peduncular scales $3\frac{1}{2}/1/1\frac{1}{2}$ ($3\frac{1}{2}/1/1\frac{1}{2}$). Dorso-hypural distance, carried forwards, falling between anterior orbital rim and centre of pupil.

The dark lateral streak is not noticeable but the precaudal spot and supra-anal pigment are still clearly seen.

Leuciscus trinema Bleeker.

Nat. Tijdschr. Ned. Indie, 1852, vol. 3, p. 600.

=*Luciosoma trinema* (Bleeker).
HOLOTYPE: BM 1866.5.2.98, Palembang, Sumatra, J. M. van Leer.

Dorsal ii.7; anal iii.6; pectoral i.15; ventral i.8. Caudal fin damaged; total length according to Bleeker, 175 mm.; standard length 134.5 mm.; depth 4.6; head 4.0; eye 4.6; snout 3.0. Lateral line 43; transverse scales $5\frac{1}{2}/1/4\frac{1}{2}$; predorsals 21; caudal peduncular scales $3\frac{1}{2}/1/2\frac{1}{2}$. A pair of maxillary barbels, equal to 0.07 times eye diameter.

The markings as originally described, are still clearly seen.

Luciosoma spilopleura Bleeker.

Nat. Tijdschr. Ned. Indie, 1855, vol. 9, p. 265.

HOLOTYPE: BM 1866.5.2.97, Lahat, Sumatra, P. L. van Bloemen Waanders.

Dorsal iii.7; anal iii.6; pectoral i.14; ventral i.8. Caudal fin damaged; total length according to Bleeker, 108 mm.; standard length 79.5 mm.; depth 4.8; head 3.7; eye 4.3; snout 3.3. Lateral line (estimated from scale pockets) 39; caudal peduncular scales $3\frac{1}{2}/1/1\frac{1}{2}$; other scale counts not possible. Barbels well developed; rostrals 3.1 times length of maxillary pair and equal to 2.4 times eye diameter.

The specimen is in poor condition and has lost most of its scales. There is no indication of the original body markings. However, each caudal lobe has a dark longitudinal band.

Rasbora borneensis Bleeker.

Act. Soc. Sci. Indo-Neerl., 1860, vol. 7, p. 450.

LECTOTYPE: BM 1866.5.2.155, River Banjer or River Duson, Banjermassin, Borneo, J. Wolff.
PARATYPE: ML 7497, same data.

Dorsal ii.7 (ii.7); anal iii.5 (iii.5); pectoral i.14 (i.13); ventral i.8 (i.8). Total length 63.0 mm. (71.8 mm.); standard length 47.9 mm. (55.0 mm.); depth 4.2 (4.5); head 4.3 (4.7); eye 3.5 (3.3); snout 3.4 (3.7). Lateral line (estimated) 31 (27); transverse scales (estimated) 4½/1/3½; predorsals 14 (13); caudal peduncular scales 4½/1/1½ (4½/1/1½). Dorso-hypural distance, carried forwards, falling opposite posterior orbital rim.

A silvery lateral stripe from opposite the dorsal origin becoming more distinct posteriorly and ending before the caudal base.

Rasbora macrocephalus Bleeker.

Atlas Ichth., 1865, vol. 3, p. 126, pl. 103, fig. 10.

LECTOTYPE: ML 2635, Krawang, Java, S. Muller.

PARATYPES (2): ML 10458, same data.

(2): ML 7039, Krawang, Java, P. Bleeker.

(1): BM 1866.5.2.150, same data.

Dorsal ii.8 (ii.7); anal iii.5 (iii.5); pectoral i.13 (i.12–i.14); ventral i.8 (i.7–i.8). Total length 74.6 mm. (57.0–67.6 mm.); standard length 57.6 mm. (45.9–56.5 mm.); depth 5.0 (4.3–5.0); head 3.8 (3.5–3.8); eye 4.1 (4.0–4.5); snout 3.6 (3.5–3.8). Lateral line 30 (25–27); transverse scales 4½/1/2½ (4½/1/2½); predorsals 12 (11–13); caudal peduncular scales 3½/1/1½ (3½/1/1½). Dorso-hypural distance, carried forwards, falling between nostril and orbit.

A silvery lateral stripe. No other markings.

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[1] A reconstruction of the dates of publication of the instalments of the *Atlas Ichthyologique* is given by Mees (1962, pp. 75–78).

Some colourful fishes of the genus *Puntius* Hamilton

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(Received February, 1963)

INTRODUCTION

Certain small and colourfully marked Malaysian fishes of the genus *Puntius* Hamilton, have for several years attracted widespread attention among aquarists. Owing to certain similarities in their colour patterns, there has been some confusion between the species concerned. Meinken (1939a & 1939b), appears to have made the first detailed comparison of the six species in question, namely, *Puntius tetrazona* (Bleeker), *P. partipentazona* Fowler, *P. pentazona* (Boulenger), *P. hexazona* (Weber & de Beaufort), *P. rhombo-ocellatus* Koumans and *P. anchisporus* (Vaillant). More recently Klausewitz (1956), considered *P. hexazona* as a subspecies of *P. pentazona* and similarly *P. partipentazona* a subspecies of *P. tetrazona*. I agree with his opinions.

This account is merely an attempt to correct the synonymy and I have not set out to re-describe the species in any detail. However, a key and illustrations are provided as an aid to identification. The following abbreviations are used:— 1. BM=British Museum (Natural History); 2. ML=Rijksmuseum van Natuurlijke Historie, Leiden; 3. MNP=Museum National d'Historie Naturelle, Paris; 4. NMS=Singapore National Museum; 5. NRS=Naturhistoriska Riksmuseum, Stockholm; 6. SMF=Senckenbergische Naturforschende Gesellschaft, Frankfurt am M; 7. St.=Natural History Museum, Stanford University; 8. USNM=United States National Museum, Washington; 9. ZMA=Zoologisch Museum, Amsterdam; 10. ZSI=Zoological Survey of India, Calcutta.

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My thanks are due to the various institutions I have listed above for allowing me to examine the material in their collections.

KEY TO SOME SPECIES OF *PUNTIUS* HAMILTON

The following key has been constructed to modify and to be interposed with that given in Weber and de Beaufort (1916: 171).

I. Linea lateralis incomplete, no rostral barbels.

b. Linea lateralis with 6 to 11 perforated plus 8 to 14 unperforated scales, excluding 1 or 2 on caudal base. Caudal peduncle surrounded by 12 scales.

(i) Dark patch on dorsal fin not extending beyond basal scale row of that fin. No dark spot on L.1. ..... *P. tetrazona tetrazona*

(ii) Dark patch on dorsal fin extending below fin base across 3 to 4 scale rows. Sometimes a dark spot below this on L.1. ..... *P. tetrazona partipentazona*

II. Linea lateralis complete.

A. Four barbels. Anal spines rather weak.

2. 7 or less scales between L.1. and dorsal.

L.1. by exception 34, generally less.

A. 12 scales round caudal peduncle.

(a) With more or less complete transverse dark bands.

2. 3–3½ scales between L.1. and ventrals. 6 transverse markings.

(*a*) 5½ scales between L.1. and dorsal.

(i) A dark spot at the base of the last dorsal ray ..... *P. pentazona pentazona*

(ii) No such spot ..... *P. pentazona johorensis*

(*b*) 4½ scales between L.1. and dorsal ..... *P. rhombo-ocellatus*

B. 14–18 scales round caudal peduncle.

(b) Height more than 2 in length.

1. L.1. 19 to 23. Caudal peduncle surrounded by 14 scales ..... *P. anchisporus.*

SYSTEMATICS

Puntius tetrazona tetrazona (Bleeker). Figure 1a.

Capoeta tetrazona BLEEKER, 1855, Nat. Tijd. Ned.-Indie, 9: 262—Lahat, Palembang province, Sumatra.

Systomus (*Capoeta*) *sumatranus* BLEEKER, 1860, Act. Soc. Sci. Indo-Neerl., 7: 354—Lahat, Sumatra.

Puntius (*Capoeta*) *sumatranus* BLEEKER, 1864–65, Atlas Ichth., 3: 108, pl. 103, fig. 11—Lahat, Sumatra.

Barbus sumatranus GUNTHER, 1868, Cat. Fish. British Mus., 7: 140—Lahat, Sumatra.

Non *Barbus sumatranus* VAILLANT, 1893a, Bull. Soc. Zool. France, 18: 57—Borneo.

Non *Barbus sumatranus* VAILLANT 1893b, Nouv. Arch. Mus. Hist. Nat., (3) 5: 82—Borneo.

Puntius sumatranus (p.p.) WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 191— Lahat, Taluk, Ringat and Deli, Sumatra.

Barbus tetrazona FRASER-BRUNNER, 1938, Aquarist & Pondkpr., 7 (12): 320, 1 fig.—Sumatra; MEIKEN, 1939b, Wschr. Aquar. Terrarienk., 36 (6): 81, fig. 1.

Puntius tetrazona tetrazona KLAUSEWITZ, 1956. Aquar. Terrar. Z., 9 (10); 259, fig. 2.

Specimens examined.—SUMATRA:—Lahat, Palembang, ML. 4951, (three syntypes), BM. 1866.5.2.208, (syntype) and BM. 1867.11.28.178 (syntype), P. L. van Bloemen Waanders; Taluk, four, ZMA. 103261, J. P. Kleiweg de Zwan, 1907; Ringat, four, ZMA. 103262, J. P. Kleiweg de Zwan, 1907; Pagar Alam, five, ZMA. 103264, leg. Mus. Bogor, 25th November 1910; no exact locality, Sumatra, one, SMF. 3741, E. Schmidt, 1955.

Bleeker (1855) originally described the species under the name *tetrazona* and it is not known why he later (1857) described another species under the same name and subsequently (1860) used *sumatranus* for the earlier species. Fraser-Brunner (1938) and Meinken (1939b) have already pointed out the mistake.

The colour pattern is remarkably similar to that of *P. anchisporus* Vaillant (1902) and it is of interest that Vaillant himself (1893a and 1893b) originally confused the two species.

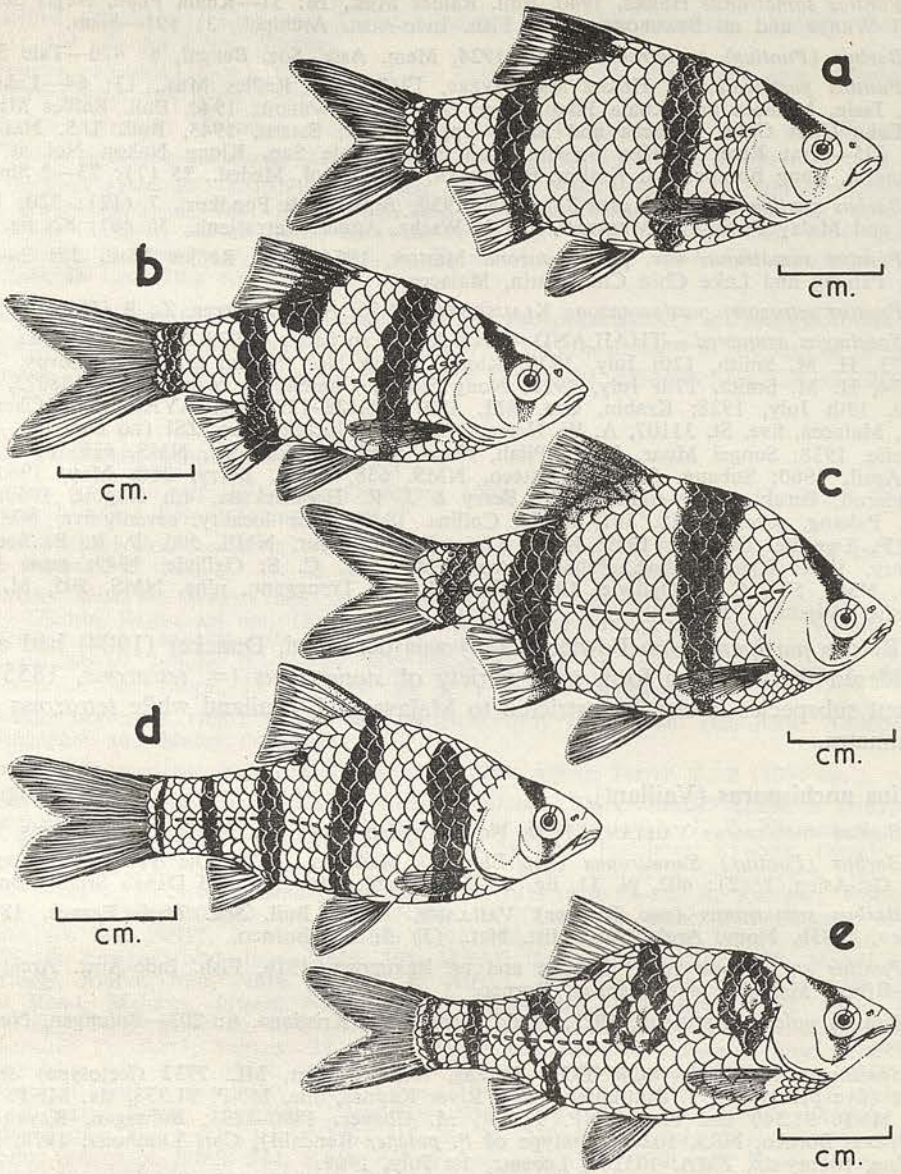

Figure 1. (a) *Puntius tetrazona tetrazona* (Bleeker), Taluk, Sumatra, 1907; (b) *P. tetrazona partipentazona* Fowler, Tasek Bera, Pahang, Malaya, 1940; (c) *P. anchisporus* (Vaillant), Poetoes Genting, Borneo, 1st July, 1909; (d) *P. pentazona pentazona* (Boulenger), Sibu, Sarawak, 28th April, 1960; (e) *P. rhombo-ocellatus* Koumans, holotype, 15 km. from Banjermasin, Borneo.

Puntius tetrazona partipentazona Fowler. Figure 1b.

Puntius partipentazona FOWLER, 1934, Proc. Acad. Nat. Sci. Philadelphia, 86: 344, fig. 8—Krat, Thailand.

Barbus sumatranus var. DUNCKER, 1904, Mitt. Naturh. Mus. Hamburg, 21: 180, pl. 2, fig. 16—Muar River, Tebing Tinggi, Negri Sembilan.

Puntius sumatranus HERRE, 1940, Bull. Raffles Mus., 16: 31—Kuala Pilah, Negri Sembilan; (p.p.) WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 191—Siam.

Barbus (*Puntius*) *sumatranus* HORA, 1924, Mem. Asia. Soc. Bengal, 6: 470—Tale Sap.

Puntius partipentazona HERRE and MYERS, 1937, Bull. Raffles Mus., 13: 64—Lake Chin Chin, Jasin, Malacca and Kuala Pilah, Negri Sembilan; TWEEDIE, 1940, Bull. Raffles Mus., 16: 74—Lake Chin Chin, Malacca and Sauk, Upper Perak; SMITH, 1945, Bull. U.S. Nat. Mus., 188: 175—Krat River at Kao Seming, Kao Sabap, Tale Sap, Klong Nakon Noi at Nakon Sritamarat, Bung Borapet and Krabin; BOESEMAN, 1957, Zool. Meded., 25 (7): 73—? Singapore.

Barbus partipentazona FRASER-BRUNNER, 1938, Aquarist & Pondkpr., 7 (12): 320, 1 fig.—Siam and Malay Peninsula; MEINKEN, 1939b, Wschr. Aquar. Terrarienk., 36 (6): 82, fig. **2.**

Puntius sumatranus var. *partipentazona* MENON, 1954, Bull. Raffles Mus., 25: 24—Tasek Bera, Pahang and Lake Chin Chin, Jasin, Malacca.

Puntius tetrazona partipentazona KLAUSEWITZ, 1956, Aquar. Terrar. Z., 9 (10): 259, fig. 2.

Specimens examined.—THAILAND:—Ban Ang, Kao Sabap, 2,000 ft. altitude, three, USNM. 103373, H. M. Smith, 12th July, 1928; Klong Nakon Noi, Nakon Sritamarat, seven, USNM. 108074, H. M. Smith, 17th July, 1928; Nong Samet, Chantabun, two USNM. 108073, H. M. Smith, 19th July, 1928; Krabin, two, BM. 1897.10.8.128–129; MALAYA:—Lake Chin Chin, Jasin, Malacca, five, St. 31107, A. W. Herre, 1934; same locality, two, ZSI (no number), M.W.F. Tweedie, 1938; Sungei Muar, Kuala Pilah, Negri Sembilan, fourteen, NMS. 639, P. Y. Berry, 7th April, 1960; Subang, Selangor sixteen, NMS. 638, P. Y. Berry, 28th May, 1960; Lake Chenderoh, Perak, twenty-eight, P. Y. Berry & J. R. Hendrickson, 4th August, 1960; Tasek Bera, Pahang, seven, NMS. 501, H. D. Collins, 1940; same locality, seventy-five, NMS. 503, M.W.F. Tweedie, October, 1949; Kuala Lipis, Pahang, four, NMS. 506, P. R. B. Speakman, January, 1958; Kuala Tahan, Pahang, two, NMS. 502, C. S. Ogilivie, 1949; same locality, three, NMS. 504, C. S. Ogilivie, 1950; Kuala Brang, Trengganu, nine, NMS. 505, M. W. F. Tweedie, August, 1950.

Before *partipentazona* Fowler (1934) was described, Duncker (1904) had already considered the Malayan form as a variety of *sumatranus* (= *tetrazona*, 1855). The present subspecies is clearly restricted to Malaya and Thailand while *tetrazona* occurs in Sumatra.

Puntius anchisporus (Vaillant). Figure 1c.

Barbus anchisporus VAILLANT, 1902, Notes Leyden Mus., 24: 96, fig. 27—Kapoeas, Borneo.

Barbus (*Puntius*) *Sumatranus* (nec Bleeker) MARTENS, 1876, Die Preussische Expedition nach Ost-Asien, 1 (2): 402, pl. 11, fig. 2—Bengkayang, Mandhor and Danau Sriang, Borneo.

Barbus sumatranus (nec Bleeker) VAILLANT, 1893a, Bull. Soc. Zool. France, 18: 57—Borneo; 1893b, Nouv. Arch. Mus. Hist. Nat., (3) 5: 82—Borneo.

Puntius anchisporus (p.p.) WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 190—Rivers Mahakan and Kapuas, Borneo.

Puntius pulcher RENDAHL, 1922, Medd. Zool. Mus. Kristiana, 6: 203—Bulungan, North-east Borneo.

Specimens examined.—BORNEO:—Sintang, Kapuas River, ML. 7732 (lectotype) and ML. 12241 (five paratypes), J. Buttikofer, 1894; River Kapuas, one, MNP. 91.338, six, MNP. 91.339, one, MNP. 91.340 and one, MNP. 91.341, M. Chaper, 1890–1891; Bulungan, Kayan River, North-east Borneo, NRS. 10279 (syntype of *P. pulcher* Rendahl), Carl Lumholtz, 1914; Poetoes Genting, twenty-six, ZMA. 103263, Lorentz, 1st July, 1909.

The specimen shown in Vaillant's figure, measuring 65.6 mm. total length, ML. 7732, is herein designated as the Lectotype.

P. pulcher Rendahl (1922) was erroneously described with an incomplete lateral line. Rendahl obviously included the unperforated scales beyond the caudal flexure in his lateral line count. The caudal peduncle is surrounded by 14 scales and not 12 scales as described.

Puntius pentazona pentazona (Boulenger). Figure 1d.

Barbus pentazona BOULENGER, 1894, Ann. Mag. Nat. Hist., (6) 13: 248—Baram, Sarawak.

Barbus (*Barbodes*) *pentazona* STEINDACHNER, 1901, Abh. Senckenb. Naturf. Gesellsch., 25 (2): 454—Baram River, Borneo.

Puntius pentazona (p.p.) WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 182—Baram River and Akah River, Borneo.

Barbus pentazona MEINKEN, 1939b, Wschr. Aquar. Terrarienk., 36 (6): 882, fig. 4.

Puntius pentazona pentazona KLAUSEWITZ, 1956, Aquar. Terrar Z., 9 (10): 288, fig. 1.

Specimens examined.—BORNEO:—Baram, Sarawak, BM. 1889.7.31.12, (three syntypes), C. Hose; Baram, Sarawak, one, BM. 1894.8.3.61, C. Hose; Akah River, Sarawak, four, BM. 1895.7.2.64, C. Hose; Baram River, Sarawak, two, SMF. 886, W. Kukenthal, 1894; Stambak, Saribas River, Sarawak, one, NMS. 512, L. K. Charles, August 1952; Sibu, Sarawak, twelve, NMS. 500, D. Cox, 28th April, 1960.

The series I have examined appear to be morphologically indistinguishable from specimens of *P. pentazona johorensis* (Duncker). The colouration in life and of preserved specimens is furthermore identical except for the slight difference in the markings as noted in the key.

Puntius pentazona johorensis (Duncker).

Barbus tetrazona var. *johorensis* DUNCKER, 1904, Mitt. Naturh. Mus. Hamburg. 21: 178, pl. 1, fig. 3—Muar River, Tebing Tinggi.

Barbus (*Barbodes*) *hexazona* WEBER and DE BEAUFORT, 1912, Fische, in: A. Maass, Durch Zentral Sumatra, 2: 527, pl. 11, fig. 2—Taluk and Gunung Sahilan, Sumatra.

Puntius hexazona WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 181, fig. 73—Djambi, Bagan api api, Taluk and Lalak on River Ingragiri, Sumatra; TWEEDIE, 1936, Bull. Raffles Mus., 12: 20—Woodlands, Singapore; HERRE and MYERS, 1937, op. cit., 13: 63—Mawai district, Johore; BOESEMAN, 1957, Zool. Meded., 25 (7): 73—? Singapore; ALFRED, 1961, Malayan Nat. Journ., 15 (1 & 2): 10, pl. 3, fig. 15—Singapore.

Puntius pentazona (p.p.) WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 182—Singapore and Malay Peninsula.

Barbus pentazona var. *hexazona* KLAUSEWITZ, 1956, Aquar. Terrar. Z., 9 (10): fig. 1, p. 258.

Specimens examined.—SUMATRA:—Gunung Sahilan, ZMA. 103200 (thirteen syntypes of *B. hexazona*) and Taluk, ZMA. 100253 (syntype of *B. hexazona*), J. P. Kleiweg de Zwan, 1907; Lalak, Indragiri, one, ZMA. 103201, donated by Mus. Hamburg; Rawang, Djambi, nine, ZMA. 103202, P. E. Moorlenburgh, 23rd April 1909; MALAYA:—Singapore, two, BM. 1912.2.2.19–20, J. P. Arnold; Singapore, two, BM. 1913.10.30.27–28, A. Rachow; Woodlands, Singapore, two, ZMA. 103202 and three, NMS. 507, Tan Teck Swee, 28th January 1913; ? Singapore, six, ML. 20912, A. Werner, 10th July 1956; Mawai District, Johore, five, St. 34727, two, ZSI (no number) and three, NMS. 508, M.W.F. Tweedie, February 1937; Mawai Estate, Kota Tinggi, Johore, four, NMS. 513, E. R. Alfred, 15th December 1957; 5¼ mile Durian Tunggal Road, Malacca, fifteen, NMS. 533, T. Selvarajah, 12th April 1960; Muar River, Tebing Tinggi, Negri Sembilan, BM. 1905.5.6.6 (ex Sel. Mus. Nr. 1295, paratype of *B. tetrazona* var *johorensis* Duncker); Subang, 24 miles from Kuala Lumpur, Selangor, four, NMS. 499, Lim Boo Liat, 24th June 1956; 4½ mile Meru Road, Klang, Selangor, sixty-two, NMS. 498, Lim Boo Liat, 3rd August 1960; Krian Swamp, Perak, six, BM. 1911.2.14.9–14, E. Seimund; Merchang swamp forest, Trengganu, forty-four, NMS. 510, M. W. F. Tweedie, August 1950; River Merchang, Trengganu, ten, NMS. 515, E. R. Alfred, 3rd July 1958; Rantau Abang, Trengganu, twenty-six, NMS. 514, E. R. Alfred, 2nd July 1958; 12th mile Kuala Brang Road, Trengganu, fifteen, NMS. 511, M.W.F. Tweedie, August 1950.

The earlier name *johorensis* Duncker (1904) is now available for *hexazona* Weber and de Beaufort (1912) which has already been considered by Klausewitz (1956) as a subspecies of *P. pentazona* (Boulenger).

Owing to the very slight difference in markings between the Bornean and the Malayan subspecies, it is not surprising that Weber and de Beaufort (1916) have confused the two forms.

Puntius rhombo-ocellatus Koumans. Figure 1e.

Puntius rhombo-ocellatus KOUMANS, 1950, Temminckia, 5: 189—15 km. from Bandjermasin, Borneo.

Barbus tetrazona BLEEKER, 1857, Act. Soc. Sci. Indo-Neerl., 2: 14—River Kahajan, Borneo.

Systomus (Barbodes) tetrazona BLEEKER, 1860, Act. Soc. Sci. Indo-Neerl., 7: 341—River Kahajan, Borneo.

Puntius (Barbodes) tetrazona BLEEKER, 1864–65, Atlas Ichth., 3: 102, pl. 144, fig. 7—River Kahajan, Borneo.

Barbus tetrazona GUNTHER, 1868, Cat. Fish, British Mus., 7: 124—River Kahajan, Borneo.

Non *Barbus tetrazona* VAILLANT, 1893a, Bull. Soc. Zool. France, 18: 57—Seboreang, Borneo.

Puntius tetrazona (p.p.) WEBER and DE BEAUFORT, 1916, Fish. Indo-Aust. Archipel., 3: 183—River Kahajan, Borneo.

Non *Puntius tetrazona* HERRE and MYERS, 1937, Bull. Raffles Mus., 13: 64—Singapore, Gunong Pulai and Kuala Pilah.

Barbus pentazona var *tetrazona* MEINKEN, 1939b, Wschr. Aquar. Terrarienk., 36 (6): 82, fig. 3.

Barbus kahajani HOEDEMAN, 1956, Het. Aquarium, 26 (12): 288, 1 fig.—River Kahajan, Borneo.

Specimens examined.—BORNEO:—About 15 km. from Bandjermasin in a canal along the highway from Oelin to Bandjermasin, ML. 16869 (holotype) and ML. 11905 (two paratypes), collected by the Zoological Gardens of the Hague; River Kahajan, BM. 1866.5.2.186, (holotype of *B. tetrazona* Bleeker, 1857), C. Helfrich.

Hoedeman has shown that *Capoeta tetrazona* Bleeker (1855), suppresses *Barbus tetrazona* Bleeker (1875) and accordingly he proposed the name *B. kahajani* for the latter. I now find that it can be referred to the present species.

The positions of the transverse markings opposite the dorsal and anal fins are not quite correctly shown in Bleeker's illustration (1864–65, plate 144, figure 7) of his type specimen. The first of these runs from the origin and anterior part of the dorsal base, not as far back along that fin base as he has shown. The marking behind this reaches the origin and anterior third of the anal base; in the *Atlas* this is shown as reaching the posterior half of the base of that fin. An additional faint, transverse stripe on the base of the caudal fin is not shown in his figure. In common with *P. pentazona pentazona* (Boulenger), there is a dark spot on the base of the last 2 dorsal rays.

I have examined the 3 specimens MNP. 91.352 and MNP. 91.353, reported by Vaillant (1893a) as *B. tetrazona* Bleeker and re-diagnose them as *P. everetti* Boulenger. I have also seen one specimen from Kuala Pilah, St. 31112, referred to this species by Herre and Myers (1937) and find it to be *P. dunckeri* (Ahl).

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Notes on a collection of fresh-water fishes from Penang

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(Received September, 1962)

INTRODUCTION

A number of publications exist which include records of fresh-water fishes from Penang. However, no single account has as yet been published which deals exclusively with the fresh-water fish fauna of the island. The earliest published records were given by Cantor (1849) who described 12 species. The subsequent publications of Duncker (1904), Regan (1910), Borodin (1932), Herre (1940a & 1940b), and Alfred (1961a) brought the total number of recorded species to 22.

This account deals mainly with a collection of some 1,060 specimens, representing 25 species, that I made, during a field-trip to Penang in October–November, 1961. The various collecting localities are shown in the map on Plate 3. Most of the specimens were taken from the lowland areas, especially, in the rice-fields (Plate 4). The numerous hill-streams (Plate 4) of the north and central part of the island are inhabited by very few species. Typical torrent forms, such as Homalopteridae, Akysidae and Sisoridae, appear to be absent.

A list of the fresh-water fishes now known from Penang, compiled from various sources, is given at the end of this paper.

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SYSTEMATICS

Mystus vittatus (Bloch).

Silurus vittatus Bloch, 1794, Ausland. Fische, vol. 8, p. 50, pl. 371, fig. 2—Tranquebar.
Mystus vittatus Smith, 1945, Bull. U.S. Nat. Mus., no. 188, p. 385, fig. 85; Jayaram, 1954, Rec. Indian Mus., vol. 51, pt. 4, p. 534, fig. 3.
Mystus gulio (not Hamilton) Alfred, 1961a, Bull. Raffles Mus., no. 26, p. 185.

Smith (1945) has commented on variation in the dark longitudinal bands and on the size of the adipose fin. In my series (Fig. 1) the dorsum is dark and the ventrum white. There are two dusky bands, one along the lateral line and the second below this extending only as far as opposite the ventral fin. In most of the specimens the lateral line is white. The adipose fin is smaller than the anal.

I now believe that the Cantor specimens which I previously listed as *M. gulio* (Hamilton), should be referred to the present species.

The specimens were taken from rice-field ditches. The species is new to Malaya.

Localities.—Kampong Sungei Kluang (seventeen); Sungei Burong (five).

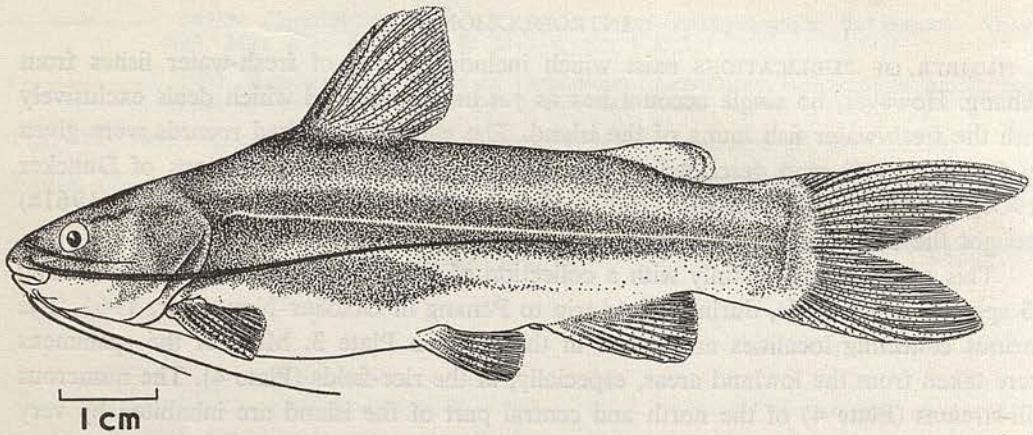

Figure 1. *Mystus vittatus* (Bloch), Kampong Sungei Kluang, 17 October, 1961.

Clarias batrachus (Linnaeus).

Silurus Batrachus Linnaeus, 1758, Systema Naturae, p. 305—Asia, Africa.
Clarias batrachus Weber and de Beaufort, 1913, Fishes Indo-Aust. Archipel., vol. 2, p. 190, fig. 74.

Specimens were taken from rice-field ditches, irrigation canals and forest streams. The species is previously reported from Penang by Cantor (1849, p. 1245) as *C. punctatus*.

Localities.—Kampong Sungei Nibong (seven); Kampong Sungei Kluang (four); Bayan Lepas (ten); Sungei Telok Bahang (one); 1 mile south-west of Batu Maung (six).

Lepidocephalus furcatus de Beaufort.

Lepidocephalus furcatus de Beaufort, 1933, Bull. Raffles Mus., no. 8, p. 32—Bukit Merah Reservoir, Perak, Malay Peninsula.
Lepidocephalus furcatus Hora, 1941, Bull. Raffles Mus., no. 17, p. 54, fig. 5.

The species is previously known from only six specimens (the types), collected from the Bukit Merah Reservoir on 18th July, 1925 and its rediscovery after more than 35 years is of particular interest.

The present collection was made from a weedy, fast-flowing, lowland stream.

Localities.—Kampong Trang (twenty-two).

Danio tweediei Brittan.

Danio (Brachydanio) tweediei Brittan, 1956, Bull. Raffles Mus., no. 27, p. 41, pl. 3—Sungei Patani, Kedah, Malaya.

The larger of the two series that I collected was taken together with *Lebistes* from polluted ditches close to human habitation.

Herre's record (1940b, p. 29) of the single specimen of *Brachydanio albolineata* (Blyth) from the Botanic Garden, Penang, could probably refer to the present species.

Localities.—Roadside ditches between Kampong Perlis and Kongsi Sepuloh (sixty-five); 1 mile south-west of Batu Maung (twenty-three).

Danio regina Fowler.

Danio regina Fowler, 1934, Proc. Acad. Nat. Sci. Philadelphia, vol. 86, p. 342, fig. 6—Nakon Sritamarat, peninsular Siam.

The present collection lends further support to Tweedie's claim (1952, p. 78) that the species is confined to the north-western part of Malaya. The species is also herein reported for the first time from Penang. Specimens were taken from a fast-flowing forest stream.

Localities.—Sungei Telok Bahang (two).

Rasbora sumatrana (Bleeker).

Leuciscus sumatranus Bleeker, 1852, Nat. Tijd. Ned. Indie, vol. 3, p. 601—Solok, Sumatra.
Rasbora sumatrana Brittan, 1954, Monogr. Inst. Sci. Tech. Manila, no. 3, p. 54.

The species abounds in the lowland streams and also occurs at the foothills. It is absent from the rice-field areas.

Specimens have been previously reported from Penang by Cantor (1849, p. 1250) as *Leuciscus rasbora* and by Brittan (1954, p. 54). The record of *R. daniconius* (Hamilton) given by Borodin (1932, p. 72) from Georgetown, very likely refers to the present species.

Localities.—Bayan Lepas (forty-seven); Sungei Telok Bahang (one); 1 mile south-west of Batu Maung (ten); Kampong Trang (sixteen); Bagan Ayer Itam (thirty-eight); Balik Pulau (one); Sungei Burong (fourteen).

Puntius binotatus (Valenciennes).

Barbus binotatus Valenciennes, in: Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, vol. 16, p. 168—Java.
Puntius binotatus Weber and de Beaufort, 1916, Fishes Indo-Aust. Archipel., vol. 3, p. 186, fig. 74.

This is another common species of the lowland streams but unlike *R. sumatrana* it does not occur at the foothills. It is also absent from the rice-field areas. The species is herein reported for the first time from Penang.

Localities.—Bayan Lepas (nine); Sungei Telok Bahang (six); Kampong Sungei Pinang (three); 1 mile south-west of Batu Maung (ten); Kampong Trang (twenty-four); Balik Pulau (eleven); Georgetown (twenty-two); Sungei Dondang, Ayer Itam (twenty); Sungei Burong (eight).

Acrossocheilus hendersoni (Herre).

Lissochilus hendersoni Herre, 1940a, Bull. Raffles Mus., no. 16, p. 10, pl. 4—Creek on Penang Island.

In their keys to the genera of Cyprininae, Weber & de Beaufort (1916, p. 92) and Smith (1945, p. 117) have separated *Acrossocheilus,* among other genera, on the basis of an interrupted postlabial goove. In my present series of 48 specimens, this characteristic is not consistent and I have some doubts about the true generic identity of this species. Thus, some of my specimens with an uninterrupted posterior groove, would key down in Smith (l.c.) to the Genus *Tor* Gray. The pectoral rays are 15–16 and not 1.13 as originally described. Mr. DeWitt who examined 5 paratypes confirmed this.

While *P. binotatus* and *R. sumatrana* are the common Cyprinids of the lowland streams, this species is characteristic at the foothills and in the torrent streams.

The nomenclature of *Lissochilus* and *Acrossocheilus* has been discussed by Myers (1941, p. 42).

Localities.—Sungei Batu Feringgi, catchment area (fifteen); Sungei Telok Bahang (fifteen); Sungei Balik Pulau (seven); Kampong Sungei Pinang (eleven).

Channa striata (Bloch).

Ophicephalus striatus Bloch, 1793, Ausland. Fische, vol. 7, p. 141, pl. 359—Malabar.

Specimens were taken from rice-fields and rice-field ditches. An adult with a brood of conspicuous, bright-orange coloured young were observed in the field on 17th October. Of these, 3 young specimens measuring 27.1–37.5 mm. total length, were collected. Cantor (1849, p. 1074), has previously recorded the species from Penang.

Localities.—Kampong Sungei Nibong (three); Kampong Sungei Kluang (one); Bayan Lepas (three); Kampong Trang (two).

Anabas testudineus (Bloch).

Anthias testudineus Bloch, 1792, Ausland. Fische, vol. 6, p. 121, pl. 322—Japan.
Anabas testudineus Weber and de Beaufort, 1922, Fishes Indo-Aust. Archipel., vol. 4, p. 334, fig. 86.

The species occurs in rice-fields, ponds and lowland streams but it does not appear to be anywhere common. Specimens have been previously reported from Penang by Cantor (1849, p. 1064), and Borodin (1932, p. 76).

Localities.—Kampong Sungei Kluang (two); Bayan Lepas (eight); Kampong Trang (two).

Betta splendens Regan.

Betta splendens Regan, 1910, Proc. Zool. Soc. Lond., 1909, p. 782—Bangkok, Menam River, Siam and Pinang, Malay Peninsula.

I am able to confirm Tweedie's observation (1952, pp. 72–73) on the distinct habitat preferences of the two species of *Betta* in Penang. The present species is restricted to the rice-fields and rice-field ditches (Plate 4). It is still much sought after for its fighting prowess.

Localities.—Kampong Sungei Kluang (two); Kampong Sungei Nibong (fifteen); Kampong Trang (two).

Betta pugnax (Cantor).

Macropodus pugnax Cantor, 1849, Journ. Asia Soc. Bengal, vol. 18, pt. 2, p. 1066, pl. 2, figs. 1–3—Fresh water, Pinang, Malayan Peninsular.

Betta pugnax Gunther, 1861, Cat. Fish. British Mus., vol. 3, p. 389; Regan, 1910, Proc. Zool. Soc. Lond., 1909, p. 779; (in part) Tweedie, Bull. Raffles Mus., no. 24, p. 73; Alfred, 1961a, Bull. Raffles Mus., no. 26, p. 183.

Betta pictum (in part, not Valenciennes) Bleeker, 1879, Verh. Akad. Amsterdam, vol. 19, p. 26.

The following description has been drawn up from the 3 syntypes in the British Museum (Alfred, 1961a, p. 183), the 7 topotypes listed by Tweedie (1952, p. 74), and the 65 other topotypes listed below. The type specimen No. 1860.3.19.930 is herein designated as the lectotype and the other two No. 1860.3.19..317–318, as paratypes.

Total length 25.4–89.2 mm. Standard length 17.5–61.1 mm. Depth at origin of anal fin 3.4–4.1. Head 2.8–3.2. Eye 2.7–4.1. Snout 3.0–3.5. Interorbital width 2.5–3.0. Predorsal length 1.5–1.6. Dorsal rays (last 2 rays counted separately) I.7–I.9. First 2 soft rays of dorsal fin articulated but always unbranched; other soft rays unbranched in juvenile specimens and branched in adults. Origin of dorsal opposite 15th–16th scale of mid-lateral scale row. Anal rays (last 2 counted separately) II.24–II.27. All soft rays of anal fin articulated and unbranched. Pectorals 13–14. Ventrals I.5. First soft ray of ventral fin articulated, unbranched and filamentous; other 4 rays branched. Mid-lateral scales, counted from upper corner of opercle to hypural, 28–30, excluding 2–4 on caudal base. Transverse scale rows between dorsal origin and base of anal 10–12, excluding 1–2 scale rows forming a sheath along the base of the anal rays. Predorsals 25–29. Maxillary not reaching behind front margin of orbit.

In small and almost full-sized specimens preserved in formalin (Fig. 2a), the dorsum is brown and the sides and undersurface light-brown. Generally there is a dark-brown stripe delineating the edge of the brown of the dorsum, running from the eye to the caudal base. This stripe may be quite pronounced or entirely absent. Laterally, there is a second stripe running from the snout, through the eye, to the caudal base. This is generally joined posteriorly with a third stripe running from the base of the pectoral fin. Behind the confluence of the two stripes is a dark brown spot on the caudal base.

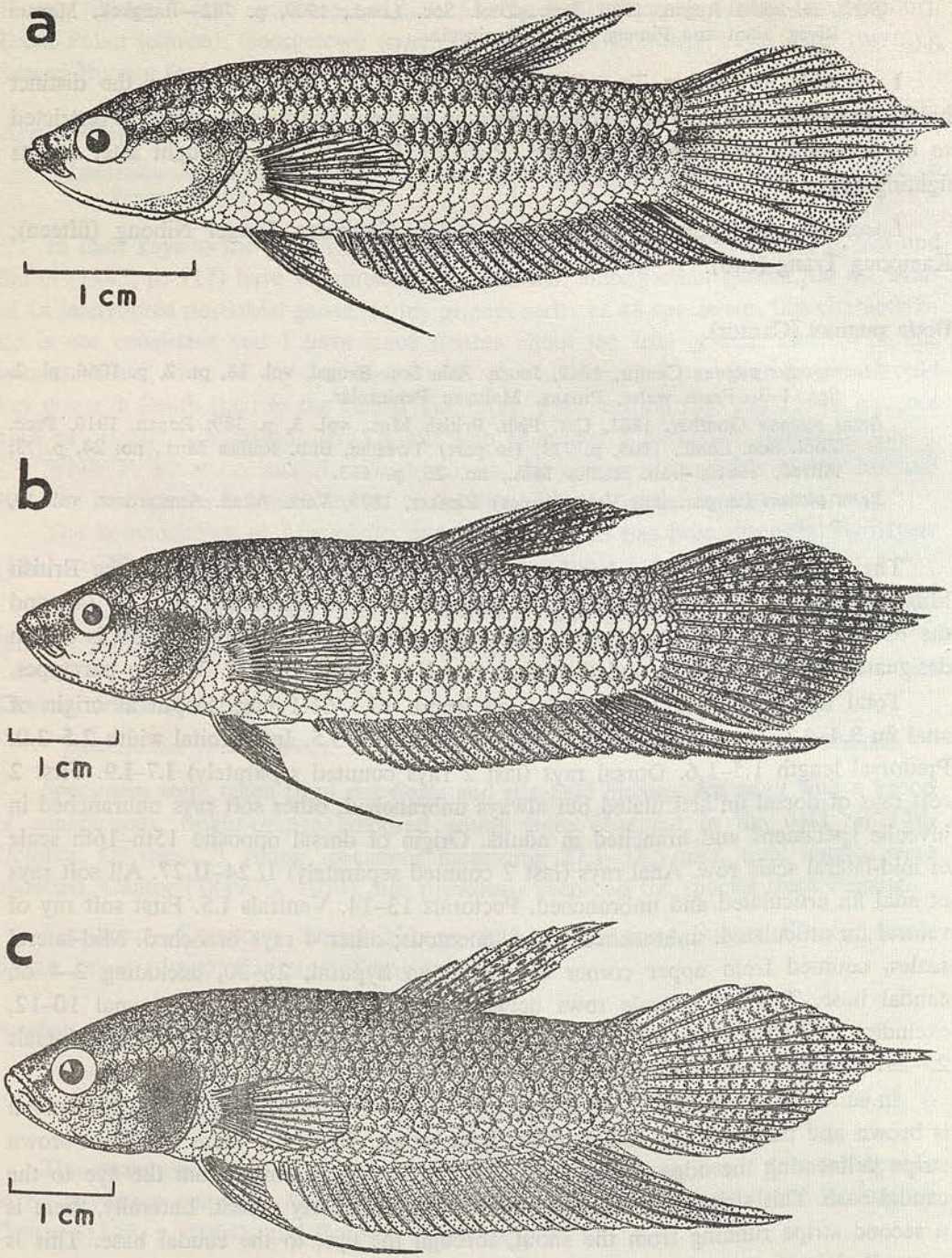

Figure 2. *Betta pugnax* (Cantor), colour patterns in (a) juvenile and (b) & (c) adult. Sungei Batu Feringgi, Catchment area, 18 October, 1961.

In the largest preserved specimens the pattern of markings is highly variable. Most have two lateral stripes (Fig. 2b). In some the space between the two stripes is completely filled with dark-brown so that there is a single broad band. In others, these markings are absent and each lateral scale has a dark spot giving an impression of many lateral stripes (Fig. 2c). There are also specimens which show intermediate markings between the broad band and two stripes and between the pattern of two stripes and many stripes. A few specimens appear to be devoid of body markings. Observations on individual live specimens show that they change freely from one pattern of markings to another in the following sequence:— broad band <———> two stripes <———> many stripes. The dorsal and anal fins are marked with dark-brown spots and lunules. The pectoral fins have a black transverse stripe near the base. None of the largest specimens show the dark spot on the caudal base.

In life, the colouration is as described except that the body has an olive-green tinge which is brightest in the largest specimens. The anal fin is reddish.

Besides *A. hendersoni,* this is apparently the only other fish that is common in the hill-streams (Plate 4). Unlike the former however, it does not enter the torrents but occurs in pools and slow-flowing stretches, especially under the overhang of the banks.

Localities.—Sungei Batu Feringgi, catchment area, (twenty-one); Bayan Lepas (twelve); Sungei Telok Bahang (twelve); Kampong Trang (eight); 1 mile north-east of Bulik Pulau (one); Sungei Dondang, Ayer Itam (eleven).

Trichopsis vittatus (Cuvier).

Osphromenus vittatus Cuvier, in: Cuvier and Valenciennes, 1831, Hist. Nat. Poissons, vol. 7, p. 387—Java.
Ctenops vittatus Weber and de Beaufort, 1922, Fishes Indo-Aust. Archipel., vol. 4, p. 351.
Trichopsis vittatus Herre and Myers, 1937, Bull. Raffles Mus., no. 13, p. 72.

The species occurs in fast-flowing ditches, usually among weeds. It has not been previously reported from Penang.

Localities.—Kampong Sungei Kluang (twenty-eight); Sungei Bayan Lepas (thirty); Kampong Trang (sixteen).

Trichogaster pectoralis (Regan).

Trichopodus pectoralis Regan, 1910, Proc. Zool. Soc. Lond., 1909, p. 784, pl. 79, fig. 1—Siam and Singapore.
Trichogaster pectoralis Smith, 1945, Bull. U.S. Nat. Mus., no. 188, p. 464.

Although this fish is common in the rice-fields and rice-field ditches and in ponds, it has not been previously recorded from Penang. The date of introduction is not known. It is much sought for as a food fish.

Localities.—Kampong Relau (four); Kampong Sungei Kluang (thirteen); Bayan Lepas (eight); Kampong Trang (three); Sungei Burong (five).

Trichogaster trichopterus (Pallas).

Labrus trichopterus Pallas, 1770, Spic. Zool., pt. 8, p. 45—East Indies.
Trichopodus trichopterus Weber and de Beaufort, 1922, Fishes Indo-Aust. Archipel., vol. 4, p. 366, fig. 93.
Trichogaster trichopterus Smith, 1945, Bull. U.S. Nat. Mus., no. 188, p. 463, fig. 98.

This is the most common species of the rice-field areas. It is also collected as a food fish. Cantor (1849, p. 1071, pl. 2, fig. 5), has previously reported specimens from Penang.

Localities.—Kampong Sungei Nibong (six); Kampong Relau (five); Kampong Sungei Kluang (twelve); Bayan Lepas (ten); Kampong Trang (seven); Sungei Burong (five).

Hemiramphodon pogonognathus (Bleeker).

Hemiramphus pogonognathus Bleeker, 1853, Nat Tijd. Ned. Indie, vol. 5, p. 193—Marawang Banka.
Hemiramphodon pogonognathus Mohr, 1936, Mitt. Zool. Mus. Berlin, vol. 21, pp. 59–63, figs. 12–14.

Specimens were collected from only a single locality, a fast-flowing forest stream. The species has not been previously reported from Penang.

Localities.—Sungei Telok Bahang (thirteen).

Dermogenys pusillus Kuhl and van Hasselt.

Dermogenys pusillus Kuhl and van Hasselt, in: van Hasselt, 1823, Algem. Konst. Letter-Bode, 1823, pt. 2, p. 131—Java.
Dermogenys pusillus Mohr, 1936, Mitt. Zool. Mus. Berlin, vol. 21, pp. 39–50, figs. 4–7.

Specimens were taken from fresh water in the rice-field areas and from brackish, tidal streams. The species is not previously reported from Penang.

Different authors have accredited the original description of the species and the genus to either both Kuhl and van Hasselt or to van Hasselt alone. My transalation (1961b, p. 85) of the original description makes it clear that they were both responsible for the diagnosis.

Localities.—Kampong Sungei Burong (ten); Bagan Ayer Itam (seven); Sungei Burong (six).

Oryzias javanicus (Bleeker).

Aplocheilus javanicus Bleeker, 1854, Nat. Tijd. Ned. Indie, vol. 7, p. 323—Perdana, Penimbang River, Java.
Aplocheilus javanicus Weber and de Beaufort, 1922, Fishes Indo-Aust. Archipel., vol. 4, p. 372.

Specimens were taken from fresh as well as from brackish water. The species has been previously reported from Penang by Alfred (1961a, p. 185).

Localities.—Batu Maung (twenty-two); Bagan Ayer Itam (fourteen); Sungei Burong (twenty).

Aplocheilus panchax (Hamilton).

Esox panchax Hamilton, 1822, Fishes of Ganges, pp. 211 and 350, pl. 3, fig. 69—Bengal.
Panchax panchax Weber and de Beaufort, 1922, Fishes Indo-Aust. Archipel., vol. 4, p. 374, figs. 96 and 97.
Aplocheilus panchax Smith, 1945, Bull. U.S. Nat. Mus., no. 188, p. 422, fig. 94.

This fish is characteristic of the rice-field ditches and the irrigation canals. Cantor (1849, p. 1234), has previously reported it from Penang.

Localities.—Kampong Sungei Nibong (forty-one); Kampong Sungei Kluang (eighteen); Bayan Lepas (five); 1 mile south-west of Batu Maung (six); Kampong Sungei Burong (nineteen); Kampong Trang (four); Bagan Ayer Itam (three); Sungei Burong (thirteen).

Lebistes reticulatus (Peters).

Poecilia reticulata Peters, 1859, Monatsb. Akad. Berlin, 1859, p. 412—Guiara River, Caracas.
Lebistes reticulatus Regan, 1913, Proc. Zool. Soc. London, 1913, p. 1008, fig. 173D.

The Guppy appears to thrive best in turbid and polluted waters which are undoubtedly highly toxic to other species. It occurs in vast numbers in the drains, canals and streams in the heart of Georgetown. The species has not been previously reported from Penang. I have not been able to ascertain when it was introduced.

Localities.—Bayan Lepas (forty-six); Roadside ditches between Kampong Perlis and Kongsi Sepuloh (twelve); Sungei Dondang, Ayer Itam (twenty-nine); Georgetown (forty-nine).

Mastacembelus maculatus Cuvier.

Mastacembelus maculatus Cuvier, in: Cuvier and Valenciennes, 1831, Hist. Nat. Poissons, vol. 8, p. 461—Moluccas.
Mastacembelus maculatus Sufi, 1956, Bull. Raffles Mus., no. 27, p. 113, pl. 20, fig. 15, pl. 21, fig. 16.

The markings on my largest specimen (total length 142 mm.), agrees well with Sufi's figure (1956, pl. 21, fig. 16). In my two smaller specimens (total length 55 mm. and 61 mm.) there are five dark brown, irregular, longitudinal stripes on each side, anastamosing posteriorly and forming rows of white spots from approximately behind the anus (Fig. 3).

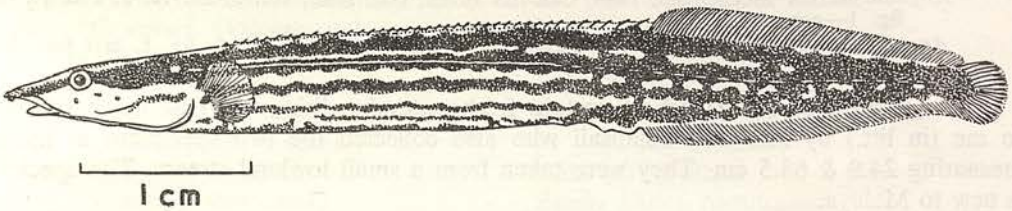

Figure 3. *Mastacembelus maculatus* Cuvier, juvenile. Sungei Balik Pulau, 30 October, 1961.

Specimens were taken from a leaf bed in a forest stream and from among rocks in a riffle. The species is new to Penang.

Localities.—Sungei Telok Bahang (one); Sungei Balik Pulau (two).

Glossogobius giurus (Hamilton).

Gobius giurus Hamilton, 1822, Fishes of Ganges, p. 51, pl. 33, fig. 15—Gangetic provinces.
Glossogobius giurus Koumans, in: Weber and de Beaufort, 1953, Fishes Indo-Aust. Archipel., vol. 10, p. 165.

This fish occurs in the turbid waters of rice-field ditches and irrigation canals. Koumans (1953), has given Cantor's *Gobius kokius* (1849, p. 1162) as a synonym of the present species.

Localities.—Kampong Sungei Kluang (seven); Sungei Burong (one).

Stigmatogobius isognathus Bleeker.

Stigmatogobius isognathus Bleeker, 1878, Versl. Akad. Amsterdam, vol. 12, p. 203—Singapore.
Stigmatogobius isognathus Koumans, in: Weber and de Beaufort, 1953, Fishes Indo-Aust. Archipel., vol. 10, p. 115.

Besides *G. giurus*, this is apparently the only other gobioid fish which occurs far enough inland to merit inclusion as a fresh-water form. The species is new to Penang.

Of particular interest was the fact that the specimens were taken in a rock-strewn riffle, in a habitat very similar to that where I have usually collected torrent-adapted forms such as Akysids and Homalopterids from elsewhere in Malaya. In Penang, the species apparently occupies an ecological position which is defined by Myers (1949) as "complementary".

Localities.—Sungei Telok Bahang (seven).

Tilapia mossambica Peters.

Chromis (Tilapia) mossambicus Peters, 1852, Monatsb. Akad. Berlin, 1852, p. 681—Tette, Sena, Quellimane, Lumbo, Inhambe and Querimba, Mossambique.

Tilapia mossambica Boulenger, 1915, Cat. Fresh-Water Fishes Africa, vol. 3, p. 154, fig. 101.

From the records available in the Fisheries Laboratory, Penang, it appears that the first introduction of the species was made into fish-ponds at Bayan Lepas in December 1949. It has since then been introduced into other localities. It has not been previously reported from Penang.

Localities.—Sungei Telok Bahang (four).

Anguilla bicolor bicolor McClelland.

Anguilla bicolor McClelland, 1844, Calcutta Journ. Nat. Hist., vol. 5, no. 18, p. 178, pl. 6, fig. 1—not seen.

Anguilla bicolor bicolor Ege, 1939, Dana Rep., no. 16, p. 151, pl. 2, fig. 8, text figs. 35 and 39.

The occurrence of the fish in certain fresh-water localities was first made known to me (in litt.) by Mr. D. Pathansali who also collected the two specimens in hand measuring 24.9 & 68.5 cm. They were taken from a small lowland stream. The species is new to Malaya.

Localities.—1 mile south-west of Batu Maung (two).

CHECKLIST

The species which are not represented in the present collection are indicated with an asterisk. Of these, the following 4 species require verification as I have not been able to re-examine the material on which the published records are given:—*Channa orientalis* (Bloch & Schneider), *C. punctata* (Bloch), *Cyclocheilichthys apogon* (Valenciennes) and *Mastacembelus erythrotaenia* (Bleeker). The previous records of *Betta picta* (Valenciennes), *Brachydanio albolineata* (Blyth), *Mystus gulio* (Hamilton) and *Rasbora daniconius* (Hamilton) are omitted from the list since they are now considered as synonyms or probable synonyms of other species represented in my collection.

Order (A) LABYRINTHICI
Family (I) ANABANTIDAE
Genus (1) *Anabas* Cuvier, 1817
1. *A. testudineus* (Bloch)
Genus (2) *Betta* Bleeker, 1850
2. *B. pugnax* (Cantor)
3. *B. splendens* Regan
Genus (3) *Osphronemus* Lacepede, 1802
4. **O. goramy* Lacepede
Genus (4) *Trichogaster* Bloch, 1801
5. **T. leeri* (Bleeker)
6. *T. pectoralis* (Regan)
21. *M. vittatus* Bloch
Family (VI) CLARIIDAE
Genus (16) *Clarias* Scopoli, 1777
22. *C. batrachus* (Linnaeus)
Order (D) PERCOMORPHI
Family (VII) CICHLIDAE
Genus (17) *Tilapia* A. Smith, 1840
23. *T. mossambica* Peters
Order (E) GOBIOIDEA
Family (VIII) GOBIIDAE
Genus (18) *Glossogobius* Gill, 1859
24. *G. giurus* (Hamilton)

7. *T. trichopterus* (Pallas)
Genus (5) *Trichopsis* Kner, 1860
8. *T. vittatus* Cuvier
Family (II) CHANNIDAE
Genus (6) *Channa* Scopoli, 1777
9. **C. orientalis* Bloch & Schneider
10. **C. punctata* (Bloch)
11. *C. striata* (Bloch)
Order (B) EVANTOGNATHI
Family (III) COBITIDAE
Genus (7) *Lepidocephalus* Bleeker, 1858–59
12. *L. furcatus* de Beaufort
Family (IV) CYPRINIDAE
Genus (8) *Danio* Hamilton, 1822
13. *D. tweediei* Brittan
14. *D. regina* Fowler
Genus (9) *Rasbora* Bleeker, 1859–60
15. *R. sumatrana* (Bleeker)
Genus (10) *Acrossocheilus* Oshima, 1919
16. *A. hendersoni* (Herre)
Genus (11) *Cyclocheilichthys* Bleeker, 1859–60
17. **C. apogon* (Valenciennes)
Genus (12) *Hampala* Bleeker, 1859–60
18. **H. macrolepidota* (Valenciennes)
Genus (13) *Puntius* Hamilton, 1822
19. *P. binotatus* (Valenciennes)
Genus (14) *Tor* Gray, 1833
20. **T. soro* (Valenciennes)
Order (C) NEMATOGNATHI
Family (V) BAGRIDAE
Genus (15) *Mystus* Scopoli, 1777
Genus (19) *Stigmatogobius* Bleeker, 1874
25. *S. isognathus* Bleeker
Order (F) CYPRINODONTES
Family (IX) CYPRINODONTIDAE
Genus (20) *Aplocheilus* McClelland, 1839
26. *A. panchax* (Hamilton)
Genus (21) *Oryzias* Jordan & Snyder, 1906
27. *O. javanicus* Bleeker
Family (X) POECILLIDAE
Genus (22) *Lebistes* de Fillipi, 1862
28. *L. reticulatus* Peters
Order (G) SYNENTOGNATHI
Family (XI) HEMIRAMPHIDAE
Genus (23) *Dermogenys* Kuhl & v. Hasselt, 1823
29. *D. pusillus* Kuhl & v. Hasselt
Genus (24) *Hemiramphodon* Bleeker, 1866
30. *H. pogonognathus* (Bleeker)
Order (H) OPISTHOMI
Family (XII) MASTACEMBELIDAE
Genus (25) *Mastacembelus* Scopoli, 1777
31. **M. erythrotaenia* Bleeker
32. *M. maculatus* Cuvier
Order (I) SYNBRANCHIA
Family (XIII) FLUTIDAE
Genus (26) *Fluta* Bloch & Schneider, 1801
33. **F. alba* (Zuiew)
Order (J) APODES
Family (XIV) ANGUILLIDAE
Genus (27) *Anguilla* Shaw, 1803
34. *A. bicolor bicolor* McClelland

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EXPLANATION OF PLATES

PLATE 3. Map of the Island of Penang, with localities where fresh-water fishes were collected.

PLATE 4. *Above:* Rice-fields and a rice-field ditch near Kampong Sungei Kluang. *Below:* A hill-stream in the upper reaches of the Sungei Batu Feringgi.

Notes and Reviews

Some comments on Banks's review of the Checklist of the Birds of Borneo. ——— I would like to comment on some of the controversial items to which Banks refers (1961, *Bull. Raffles Mus.*, **26:** 201–202) in his review of my Checklist of the Birds of Borneo (1957, *Sarawak Mus. Journ.*, **7:** 523–818).

"The Bintulu Mallard (43) has a green speculum, and is probably the Australian Mallard, *Anas superciliosa.*" The skin was sent to Mr. J. D. Macdonald of the Bird Room, British Museum (Natural History) who has kindly examined it and reports (in a letter dated 11th May 1961): "There is no question about it being anything other than a female Pintail, *Anas acuta.* It is a perfect match with specimens here. There is a trace of green in the speculum, which is usually a bronze-brown, but this is a slight leaning towards the male characteristic—no more I would imagine than a rather hirsute lip on a human female."

"The Sibu Tufted Duck (49) may have come from the Sultan of Johore's lake." In 1959 there was quite an invasion of this species to the Kra swamp area near Kota Belud in North Borneo. Mr. P. F. Burgess, Deputy Conservator of Forests, sent down two specimens, which are now in the Sarawak Museum, and reported that numbers had been shot by natives. This suggests that the Tufted Duck may be rather more common as a winter visitor than the formal records indicate. There is no reason to suspect that any or all of them come from the Sultan of Johore's lake.

"There is no mention of the possible appearance of the nominate race of the Marsh Harrier (72) . . ." *Circus aeruginosus aeruginosus* is recorded by Chasen for the Malay Peninsula and Sumatra, like the Shikra (*Accipiter badius poliopsis*). One could compile quite a list of birds whose appearance in Borneo is not beyond the bounds of possibility.

"The Grey Plover (109) is purely a shore bird, and not 'partial to lawns'." It is dangerous to make dogmatic statements about birds. I have seen Grey Plover on the smooth lawn of the War Memorial Cemetery on Labuan Island. I agree that the Golden Plover is the species typically seen on lawns.

"Many waders in pre-war times, at least, were passage migrants ——— they were not taken or recorded in December or January." We have January or February records for nearly all the waders now. Mr. Banks claims that Swinhoe's Snipe was not taken or recorded in December or January, but he himself shot one at Kuching on 16th December.

"The migration described for the House Swift (245) is more characteristic of the Pacific Swift, as yet not known from Borneo." Mr. Banks who himself described this migration (on 11th December 1925 at Bintulu) did not suggest, when he published his note, that the birds were *Apus pacificus,* but the idea had occurred to me recently that they may well have been of that species. Observers should be on the look out for this bird.

The review contains some interesting information, and it is unfortunate that it appeared too late for this information to be incorporated in my book on the Birds of Borneo published in December 1960. ——— B. E. SMYTHIES, *Forest Office, Kuching, Sarawak,* 20th May, 1961.

Channa bistriata **(Weber and de Beaufort), the young of the Snake-head fish** *Channa lucius* **(Cuvier).** ———— In the original description of *Channa bistriata,* Weber and de Beaufort (1922, *Fish. Indo-Aust. Archipel.,* **4:** 322) included the comment that it possibly represented the young of *C. lucius* (Cuvier). The species was characterised with 4½ scales between the anterior rays of the dorsal fin and the lateral line and with body markings consisting of 2 black longitudinal bands, as against 5½ scales and a single interrupted lateral band in *C. lucius.*

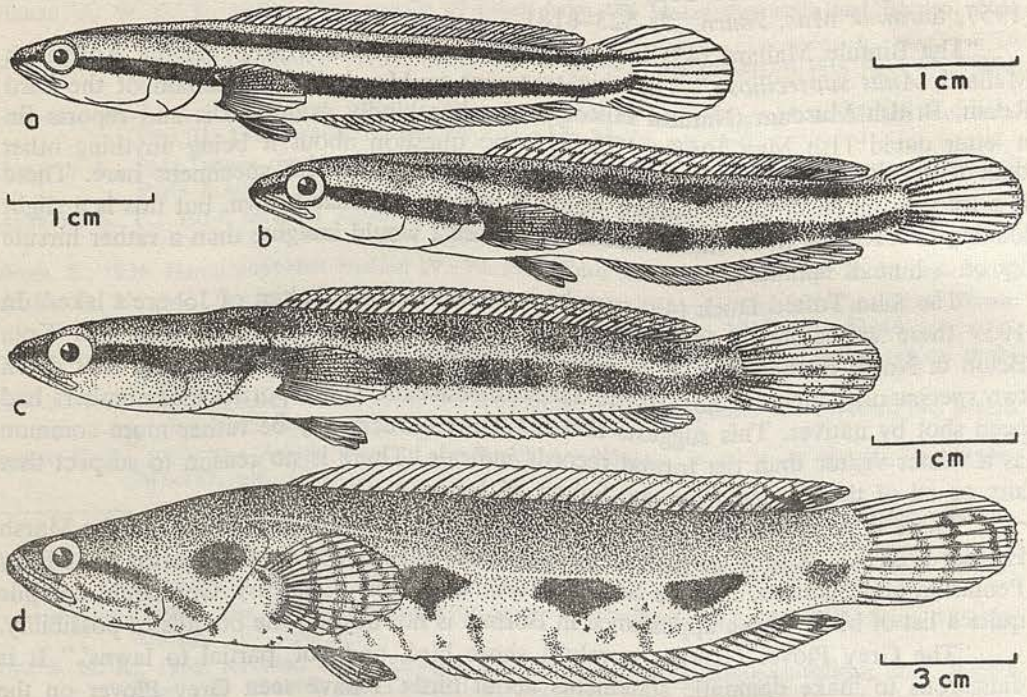


Figure 1. Stages in the colour pattern of *C. lucius* (Cuvier). (a) Nee Soon, Singapore, April 1958. (b) Aquarium specimen, July 1958, from Nee Soon, April 1958. (c) Maran, Pahang, August 1956. (d) Nee Soon, Singapore, April 1958.

Tweedie (1936, *Bull. Raffles Mus.,* **12:** 22) listed the species (with 4 specimens identified by de Beaufort) from the Bukit Merah Reservoir and later Herre and Myers (1937, *op. cit.* **13:** 70) recorded 26 specimens from Singapore. Tweedie (1949, *op. cit.,* **21:** 104) further maintained that *C. bistriata* was a diminutive species and could not represent the young stage of *C. lucius* since he had specimens of *C. lucius* about equal to and smaller than the *C. bistriata* but without the 2 pairs of lateral bands and already with the characteristic markings of the adult. I have examined the entire series of 23 specimens of *C. lucius* which were available to Tweedie at that time and can find only 2 such specimens. They measure 68.2 and 74.0 mm. total length and were collected by Cedric Dover from Ampang, Selangor, 28th August, 1926. His specimens of *C. bistriata* consist of 2 measuring 65.5 and 68.9 mm. from Herre's series from Singapore and 4 of 26.0 to 31.5 mm. from the Bukit Merah Reservoir. It will be noted that the smaller *C. lucius* is only 0.7 mm. smaller than the largest *C. bistriata.* Tweedie's observation based on this single specimen is hardly significant and furthermore relative size alone is no criterion of the relative age since growth rates can vary. The description he gives of

the markings on those 2 specimens, i.e., "two alternating series of lateral blotches characteristic of the adult", is also not for the adult of the species but for young specimens according to Weber & de Beaufort (1922: 326).

Observations on additional specimens were made possible through the kindness of Dr. J. R. Hendrickson of the University of Malaya when with his assistance I collected a brood of 29 young together with an attendant adult female *C. lucius* from the Swamp Forest area at Nee Soon, Singapore in April 1958. 10 young were kept alive. The remaining series of 19 young (Fig. 1a), were found to agree closely with the original description of *C. bistriata* except for the presence of 5½ scale rows between the anterior dorsal rays and the lateral line. A re-examination of the 4 specimens from Bukit Merah and the 2 others from Singapore also gave a similar scale count. Mr. J. J. Hoedeman of the Zoologisch Museum, Amsterdam, kindly allowed me to examine the 3 type specimens of *C. bistriata* (ZMA 103187) in his museum. The scale counts between the anterior dorsal rays and the lateral line are 5½ and not 4½ as originally described.

Of the 10 live specimens a single survived until July 1958, developing the markings corresponding to those given for young specimens by Weber and de Beaufort. My observations indicate that these markings (Fig. 1b), are transitory between younger specimens and the adult (Fig. 1d). I have recently (1961, *Malayan Nat. Journ.*, **15:** 15, pl. 4, figs. 24a & 24b) given a brief account of these colour changes. ———— ERIC R. ALFRED, *Singapore National Museum,* 1st August, 1961.

A Syngnathid fish mentioned by van Hasselt. ———— In the published extract of a letter from J. C. van Hasselt to C. J. Temminck in *Algemeene Konst-en Letter-Bode,* 1823, part 1, no. 21, p. 329, there appears the following statement: "Van de Lophobranchien leeft in de rivieren bij Batavia een *Syngnathus,* dien ik heb doen afbeelden, en den naam *Fluviatilis* gegeven heb." The whereabouts of his specimens and the drawing that was prepared remained unknown until Bleeker (1853, *Verh. Bat. Genootsch.,* **25:** 1 & 18), pointed out that the manuscript drawing had been left behind in Java and he provided a description of the species from this drawing under the name *Syngnathus fluviatilis* Bleeker. In a later publication Bleeker (1859, *Act. Soc. Sc. Indo-Neerl.,* **6:** 188), listed it as a species of *Doryichthys* Kaup, but Dumeril (1870, *Hist. Nat. Poissons,* **2:** 598), referred the species to *Microphis* Kaup as he did with all other species of that genus. None of the foregoing descriptions however, adequately characterised the species and accordingly Duncker (1915, *Mitt. Naturh. Mus. Hamburg,* **32:** 55), and Weber & de Beaufort (1922, *Fish. Indo-Aust. Archipel.,* **4:** 55), described it as a species of doubtful status under the name *D. fluviatilis* (Bleeker), with the comment that it was probably identical with *D. deokhatoides* (Bleeker).

In the course of re-examining the Kuhl and van Hasselt collection of fishes in the Rijksmusum van Natuurlijke Historie, Leiden in 1959, I located a specimen (No. 3852) of *Microphis brachyurus* (Bleeker) labelled "Syngnathus fluviatilis". It was this label apparently that led Kaup (1856, *Cat. Loph. Fish British Mus:* 57), to include van Hasselt (1825) and Bleeker (1853) in his synonymy of the description of the specimen as *Doryichthys hasselti* Kaup. The specimen which is consequently a cotype of *D. hasselti* Kaup, is mentioned in Weber & de Beaufort (1922, *op. cit.,* **4:** 55). In addition to this, I found a dry specimen (No. 1626) of *Microphis boaja* (Bleeker) which was labelled likewise and presumably in error, as "S. fluviatilis". No other specimens were found and it is believed that the fish collected by van Hasselt has been lost.

At the instigation of Dr. M. Boeseman, Curator of Fishes of that Museum, I examined Bleeker's unpublished manuscript drawings of Syngnathids that were intended for his *Atlas Ichthyologique*. Of particular interest was the presence here of a drawing labelled *Syngnathus fluviatilis* Bleeker. The fact that it was found to agree in most respects with the details given in Bleeker's description, and since Bleeker had not subsequently reported that he obtained any specimens, would seem conclusive in itself that this is a copy of if not the actual drawing mentioned by van Hasselt. A close examination of the quality of the paper used and the colour of the paints revealed noticeable differences from the other manuscript drawings affixed on the same Atlas place. The Museum in Leiden besides, possesses a van Hasselt manuscript drawing of *Belontia hasselti* (Cuvier). The type of paper used is similar in both drawings. In September 1961, Dr. L. D. Brongersma, Director of the Rijksmuseum, kindly sent me his own detailed notes taken from his manuscript on Syngnathidae. In this he states to have seen manuscript notes by van Hasselt, containing a description of *Syngnathus fluviatilis* with a reference to the drawing. The description agrees in essential details with the illustration included among Bleeker's unpublished Atlas plates.

From the following brief description I made from the drawing, I now have little doubt that van Hasselt's Syngnathid is *Doryichthys deokhatoides* (Bleeker):—
Dorsal 29; anal, none indicated; pectoral 21; caudal 9; rings 18 + 30; subdorsal rings 2 + 5; total length 136.7 mm.; standard length 133.2 mm.; depth 17.1; head 6.8; eye 6.7; snout 1.8; post orbital 3.3; trunk 3.1; tail (with caudal) 1.8; Superior cristae of trunk and tail discontinuous. Median cristae of trunk and inferior cristae of tail discontinuous. Inferior cristae of trunk and tail continuous. Operculum with a complete longitudinal keel. Colouration, brownish; laterally on the superior crista of the trunk, a darkish spot on the anterior edge of the 6th to 13th rings. ———— ERIC R. ALFRED, *Singapore National Museum,* 22nd November, 1961.

The occurrence of *Amoebidium parasiticum* Cienkowski in Singapore. ———— On 14th December, 1961 I received a collection of the cladoceran *Moina* from a temporary pool at Shrewsbury Road, Singapore. These belonged to a new species allied to *M. macrocopa* which I intend to describe elsewhere under the name *M. triunguiculatus*. The population was very overcrowded and males were abundant. Most of the individuals were covered with a dense growth of epibiotic organisms. These included a species of *Vorticella* and also large numbers of the peculiar organism *Amoebidium parasiticum* Cienkowski.

All stages of this epibiote were present. They agreed in all details with the equivalent stages which I have observed in populations of *A. parasiticum* occuring on *Daphnia* in England (Johnson, 1952, *J. Queckett micros. Club, Lond.,* (4) **3:** 387). I have previously observed occasional individuals, usually young stages, on *Moina dubia* in Malaya but I have never found it in any abundance before.

As with the English material which I examined, so also in Singapore, production of amoebulae was comparatively rare but showed a tendency to be synchronous amongst the specimens occuring on a single host.

The species is known from Poland (Cienkowski, 1861, *Bot. Ztg.,* **19:** 169), France (Moniez, 1886, *C. R. Acad. Sci., Paris,* **104:** 183; Pacaud, 1939, *Bull. biol. Fr.-Belg., suppl.,* **25:** 150, 153 & 155), Spain (Margalef, 1946, *Contribution al conocimento hidrobiologico del Pais Vasco-Navarro,* 31), England and Denmark (Johnson, 1952, *op. cit.*), and North America (Taylor, 1928, *J. Elisha Mitchell Sci. Soc.,* **44:** 126) where it is widely distributed. It has not previously been reported from the tropics.

In England this species is abundant in winter; but I failed to find it in England during the summer months. However I did find it in small numbers in Denmark during the summer. These records would suggest that it was a cold-water form. Thus its occurrence in Singapore becomes somewhat surprising. A possible explanation is that, like many other epibiotes of Cladocera, *Amoebidium parasiticum* can only establish itself in any numbers in populations of weakened individuals living under bad conditions. Such conditions are most usual during the winter months in England; but since temperature is only one of many factors involved, favourable conditions for *Amoebidium parasiticum* may occur even in warm climates in colonies of cladocerans weakened by bad conditions. ———— D. S. JOHNSON, *Department of Zoology, University of Singapore,* 20th December, 1961.

Records of aquatic insects caught at light in Kahang, Johore. ———— In a previous paper (Fernando, 1961, *Bull. Singapore Nat. Mus.*, **30:** 19–31), I recorded 15 species of aquatic Hemiptera and 29 species of aquatic Coleoptera from various parts of Malaya. All except one of these collections came from Northern Malaya and this single locality was Gemas, Johore. In the present note a number of species are recorded from Kahang (near Kluang), Johore from two light trap catches.

The first catch was made on 29th April, 1961 using a kerosine pressure lamp hung over a tray containing liquid paraffin in a rice-field. The following species were taken: COLEOPTERA ———— *Helochares abnormalis* Sharp, *Paracymus evanescens* Sharp, *Enochrue rubrocinctus* Reg. and *Enochrus* sp. (Hydrophilidae); *Guignotus inconstans* (Walk.), *Copelatus tenebrosus* Reg. and *Uvarus genitalis* Sharp (Dytiscidae); *Hydrocoptus bosschae* Sharp and *Canthydrus ritsemae* Reg. (Noteridae); *Scirtes holosericeus* Ch., *Scirtes* 2 spp. and *Cyphon* sp. (Helodidae); HEMIPTERA ———— *Micronecta quadristrigata* Breddin and *M. punctata* Fieb. (Corixidae).

The second catch was made by Mr. J. R. Pippet on 26th November, 1961 from 7.30–9.30 p.m. and on the following day from 5.00–6.00 a.m. An Ultraviolet light trap of the Robinson-type was used in Sungei Kahang Estate. The following species were taken: COLEOPTERA ———— *Sternolophus rufipes* F., *Helochares abnormalis, H. taprobanicus* Sharp, *H. pallens* MacL., *Enochrus rubrocinctus, Paracymus evanescens, Amphiops pedestris* Sharp, *A. pisiformis* Sharp and *Psalitrus* sp. (Hydrophilidae); *Hydraticus vittatus* F., *Hydrovatus bonvolouri* Sharp, *H. tinctus* Sharp, *H. confertus* Sharp, *H. acutus* Sharp, *Uvarus genitalis* Sharp, *Guignotus inconstans, Laccophilus chinensis* Walk. *Copelatus tenebrosus* and *Copelatus* sp. (Dytiscidae); *Hydrocanthus indicus* Wehn, *Canthydrus ritsemae* and *Hydrocoptus bosschae* (Noteridae); *Scirtes holosericeus* and *Scirtes* 2 spp. (Helodidae); *Bhyrrinus subregularis* Pic (Bhyrridae); HEMIPTERA ———— *Sphaerodema molestum* (Duf.) (Belostomatidae); *Limnogonus parvulus* Stal (Gerridae); *Anisops nivea* (F.) and *Nychia* sp. (Notonectidae); *Plea liturata* Kirk. (Pleiidae); *Micronecta quadristrigata, M. punctata, M. scutellaris* Stal, *M. albifrons* Motsch., *M. ludibunda* Breddin *M. issa* Distant and *M. thyesta* Distant (Corixidae).

Most of the species recorded here have been already recorded by me (1961, *op. cit.*). The additional records include the helodids *Scirtes holosericeus, Scirtes* 2 spp. and *Cyphon* sp. The Helodidae have not so far been recorded at light in Malaya. The other new records are *Amphiops pisiformis, Hydrocanthus indicus, Canthydrus ritsemae, Guignotus inconstans, Uvarus genitalis, Copelatus tenebrasus, Bhyrrinus subregularis,*

Anisops nivea, Micronecta punctata, M. albifrons, M. ludibunda, M. issa and *M. thyesta*. All these species of *Micronecta* are also new records for Malaya. A single badly damaged specimen of *Nychia* sp. is interesting because it is the first record of this genus at light.

The Dytiscidae and Noteridae on the one hand and the Hydrophilidae on the other are represented by about equal numbers as regards species. In total number of individuals however, the former greatly exceed the latter. This is unusual for light trap catches but probably reflects the faunal composition of southern Malaya.

Of the aquatic Hemiptera, only the Corixidae were taken in numbers. Of these *Micronecta quadristrigata* was by far the commonest. This species is the most frequently recorded species of *Micronecta* at light besides being the most widely distributed in South East Asia. ———— C. H. FERNANDO. *Department of Zoology, University of Singapore,* 3rd January, 1962.

The occurrence of *Simocephalus latirostris* Stingelin (Crustacea: Cladocera) in South-East Asia. ———— On 27th March, 1962, I collected several small specimens of a *Simocephalus* from an unpolluted, weedy ditch at mile 17, Jurong Road, Singapore. On examination these proved to be the rare species *Simocephalus latirostris* Stingelin. First described from Paraguay by Stingelin (1906, *Ann. Biol. Lacustre,* **1:** 181–192), this species was for long believed to be confined to South America. It thus formed one of the comparatively few apparent exceptions to the generalization that tropical Cladocera tend to be pan-tropical in distribution, rather than confined to definite geographical regions. Recently Fryer (1957, *Arch. Hydrobiol. Plankt.,* **53:** 223–239), reported it from three localities in Nyasaland. In this report Fryer adds some details to our knowledge of its structure. The present occurrence in Singapore thus indicates that it is a truly pan-tropical species.

The Singapore specimens agree very well with Fryer's re-description and agree with this description in the points on which it departs from Stingelin's original account. In particular it may be noticed that, although the carapace markings are best described as reticulate, the reticulation has clearly been developed on the basis of the more usual sculpture of oblique parallel lines found in this genus. In *S. latirostris* these lines are further apart than is usual and moreover are somewhat wavy, especially near the ventral carapace margin. The occasional cross-bars are more numerous as are also anastomoses between the oblique lines. The result is that in some regions the oblique sculpturing is almost completely obscured, whilst everywhere there are pronounced reticulate tendencies. In my specimens the ocellus has the same general form as in the specimens figured by Fryer, rather than the lozenge shape shown by Stingelin. However, my specimens have the ocellus longer than in Fryer's figures, approaching the conditions shown in *Simocephalus vetulus* (O. F. Muller). Most of my specimens are young so that the carapace is more nearly rectangular than in previously figured specimens. The so-called 'spine' is thus situated more dorsally. These are the sort of changes in form with age which are well-known in females of the family Daphniidae.

The problem remains as to why this species has been so rarely reported. Undoubtedly it could be confused with *S. vetulus*. For instance, Brehm (1933, *Arch. Hydrobiol. Plankt., suppl.,* **11:** 631–771), suggested that it was a merely a monstrous form of that species, though he changed this opinion in later works. Nonetheless it is

difficult to avoid the conclusion that it is really a rare species. Fryer's records are the only ones from Africa. It did not occur in the extensive collections of the Deutschen Limnologischen Sunda-Expedition; and I have not previously encountered it in Malaya or Sumatra. One would therefore suspect that it requires rather well-defined and unusual conditions. Fryer suggests, on the basis of its distribution in Nyasaland, that it is a stenothermal form requiring high temperature. This may well be true but it does not explain its rarity in countries such as Malaya. The Singapore habitat had a noon-day temperature of 27.8° C, well within the normal temperature range for freshwater habitats in Singapore.

This locality has abundant *Utricularia* together with a fair quantity of floating vegetation consisting of *Nymphaea* and *Jussiaea*. The water is clean and clear, though slightly peaty. The oxygen content at this visit was 20% saturation. On a previous visit it was 93%+. These low values agree with the presence of air-breathing fish in abundance, though the presence of a flourishing population of the blackwater cyprinid, *Rasbora einthovenii* (Bleeker), suggests that the oxygen must seldom fall lower than the lowest of these values. The pH of 5.6 is low, but not exceptionally low for a Singapore habitat. The alkalinity using B.D.H. 4.5 indicator corresponded to a value of only 9.8 parts of bicarbonate ion per million. This value is low; like the low pH it represents conditions often encountered in forest and tree-country streams in S. Malaya but somewhat unusual in open country habitats. There was a fairly rich fauna of associated Cladocera including: *Ilyocryptus spinifer* Herick, *Macrothrix sumatrensis* (Brehm), *Kurzia longirostris* (Daday), *Alona affinis* (Leydig), *Chydorus eurynotus* Sars, and *Dadaya macrops* (Daday). Of these only *I. spinifer* and *A. affinis* can be considered as well-known species. *Macrothrix sumatrensis,* and *K. longirostris* had not previously been found in Malaya.

Fryer gives the habitat in Nyasaland as amongst dense submerged vegetation near the margin, a description which indicates conditions similar in this respect to the Singapore habitat. He notes that in two of the three habitats it was associated with *Simocephalus serrulatus*. The latter species is normally found in acid waters. Fryer also records *Kurzia longirostris* from one of these habitats. From two of these habitats Fryer records the conchostracan, *Cyclestheria hislopi* (Baird). This species is usually found in habitats which periodically dry out in whole or in part. The Singapore habitat had partially dried out during a recent drought.

An attempted synthesis of this information suggests that *Simocephalus latirostris* requires the following conditions: a moderately high and reasonably constant temperature; a small, shallow water-body with abundant submerged vegetation; acid water; and possibly in addition the liability of the habitat to dry out, at least in part. The Singapore record shows that it can flourish in conditions of low oxygen; but this cannot as yet be established as a necessary factor. In addition it seems probable that the habitat should have clear water and be unpolluted. This combination of conditions is sufficiently uncommon in the tropics to account for the apparent rarity of the species. ————

D. S. JOHNSON, *Department of Zoology, University of Singapore,* 31st March, 1962.

A preliminary note on the Acephaline Gregarines (Protozoa: Sporozoa) of some Malayan Earthworms. ——— Acephaline gregarines are common parasites in the seminal vesicles of earthworms. In Malaya, no investigations have so far been made on these protozoans. In a preliminary survey of some of the commoner species of earthworms, eight species have been found.

Three of these gregarines have been identified to species, namely *Stomatophora coronata* (Hesse), *S. diadema* Hesse and *Choanocystoides costaricensis* Martiis. Besides these, three genera were recognised, namely *Monocystis* Stein, *Apolocystis* Martiis and *Craterocystis* Martiis. It is hoped that a more detailed account will be published later.

Five species of earthworms were investigated. The distribution of gregarines in these five species is as follows:—

Pheretima peguana (Rosa):
Stomatophora coronata (Hesse), *Monocystis* sp. A and *Apolocystis* sp.

Pheretima hawayana (Rosa):
Stomatophora diadema Hesse and *Monocystis* sp. B.

Pheretima elongata (Perrier):
Stomatophora coronata (Hesse) and *S. diadema* Hesse.

Pheretima indica (Horst):
Choanocystoides costaricensis (Martiis).

Drawida nepalensis Michaelson:
Craterocystis sp. and *Monocystis* spp. A and B.

Both smears and sections of seminal vesicles were studied for their parasites. For detailed morphological study, fresh smears were made in Normal Saline (0.7 per cent). The cover-slip was supported by crushed pieces of cover-glass to prevent distortion of the parasites. The material was then irrigated with vital stains, Neutral Red and Janus Green. Smears and whole seminal vesicles were fixed in Schaudinn's Fluid. Sections and smears were then stained in Heidenhain's Iron Haematoxylin or Mallory's Triple Stain. Smears were also stained in Geimsa for preliminary examination.

Measurements were made of the trophozoites and sporocysts in both smears and sections. It was found that whilst sporocyst sizes were constant for a given species, those of trophozoites show slight differences. In smears the trophozoites are larger due to a certain amount of flattening, whilst in sections they tend to shrink.

Stomatophora coronata (Hesse). This species has an oval body, the anterior end of which bears a sucker, surrounded by a crown of petals. The trophozoites are 52–67u × 20–50u, and have truncated sporocysts of sizes 17–19u × 9.6–11.2u.

Stomatophora diadema Hesse. The specimens are large, flattened and disc-like, with a sucker surrounded by a very large crown of petals, which tend to hide the body. They measure up to 140–160u in diameter. The sporocysts are large and measure 17–19u × 8–10u from one truncated end to the other. This species and *S. coronata* are widespread in Malaya.

Choanocystoides costaricensis Martiis. The trophozoites are cup-shaped with a ciliated crater at the anterior end. They measure up to 60–80u in diameter. The truncated sporocysts are 12.0 × 4.8u. This agrees very closely with the description of *C. costaricensis* given by Martiis (1925, *Monit. Ital. Firenze,* **36:** 219).

Only one species of the genus *Choanocystoides* has so far been recorded, in Central America. In Malaya, it occurs in one species of earthworm, *Pheretima indica* ———— WINNIE C. CHIA, *Department of Zoology, University of Singapore,* 29th January, 1962.

Some new records of parasitic Crustacea from Malayan fresh waters. ———— Whilst making fresh-water collections during the last two years, three new records of parasitic crustaceans were obtained, namely, *Argulus indicus* Weber, *Alitropus typus* Milne Edwards and *Tachaea chinensis* Thielemann.

Argulus indicus was first described from Java by Weber (1892, *Zool. Eregebn. Niederl. Ost. Ind.,* **2:** 544). He found only females. The male was first described from Thailand by Wilson (1927, *J. Siam Soc., Nat. Hist. Suppl.,* **7:** 1). The species has also been recorded in India by Ramakrishna (1951, *Rec. Indian Mus.,* **49:** 208). Our material consists of one male and two females from *Aplocheilus panchax* (Hamilton) taken in April 1961 at the MacRitchie Reservoir, Singapore. *Argulus indicus* has been recorded on many species of fishes but *Trichogaster pectoralis* (Regan) is supposed to be the "real" host according to Wilson (1944, *Proc. U.S. Nat. Mus.,* **94:** 552).

Alitropus typus has been reported both from fresh and salt water in Indonesia, Borneo and India (Nierstrasz and van Swinderen 1931, *Arch. Fur Hydrohiol., Suppl.,* **9:** 399). Our material was collected from *Channa gachua* (Hamilton) at Batu Berendam and the Kuala Pilah—Tampin Road, Malacca. Eight specimens, consisting of both males and females were obtained.

Tachaea chinensis has hitherto been recorded from only China and Japan (Shen, 1936, *Bull. Mem. Inst. Biol.,* **7:** 18). Our material consists of 4 specimens collected on *Macrobrachium geron* Holthuis from Gunong Pulai, Johore.

We are indebted to Mr. R. W. Ingle, British Museum (Natural History) and Mr. P. Kirtisinghe, Aquinas University College, Colombo, Ceylon, for the identifications.
———— A. KARIM, *Fisheries Laboratory, Glugor, Penang* and C. H. FERNANDO, *Department of Zoology, University of Singapore,* 12th June, 1962.

The larva of the Cockle, ***Anadara granosa*** **Linn.** ———— The full-grown larva of the variety of the cockle, *Anadara granosa bisenensis,* an economically important species in Japan, is described and figured by Yoshida (1957, *Journ. Shimonoseki College Fisheries,* **6** (3): 63–66). This larva differs from the larva of *Anadara granosa* as found locally in the following features:—

(*a*) The full-grown larva attains a much larger size—0.218 mm. to 0.268 mm. in length.

(*b*) The larva is longer; the ratio of length to height is 1.23 to 1.34.

(*c*) The number of concentric lines is fewer, about 7.

(*d*) The shape is more ovate-oblong.

My identification of the larva was based entirely on shell characters, shape, hinge structure, and texture from Rees (1950, *Hull. Bull. Mar. Ecol.,* **3** (19): 78–80). The initial identification was made by comparing the clearly defined prodissoconch on early spat collected during July to October, 1958, at Kuala Jalan Bharu, Penang, with planktonic larvae collected during the same period. The initial identification was later confirmed by culturing the planktonic larva in the laboratory.

TABLE 1

Measurements of the right valve of the larva of *Anadara granosa* Linn. from Penang.

Length in mm.	Height in mm.	Length/Height
0.187	0.166	1.13
0.192	0.170	1.13
0.198	0.170	1.12
0.200	0.177	1.13
0.203	0.180	1.13
0.208	0.183	1.14

The smallest shell collected measured 0.192 mm. in length by 0.166 mm. in height, while the prodissoconch measured 0.187 mm. by 0.161 mm. The full-grown larva, in which the foot is well developed and on keeping in the laboratory for 24 hours, or even less, quit the free swimming stage to settle to the bottom of the dish and to crawl about actively, measured from 0.187 mm. to 0.208 mm. in length. The accompanying table gives the measurements of a single valve, the right, with the ratio length/height.

The larval shell is strong and convex with prominent but bluntly rounded umbones widely separated from each other. The anterior is narrow and slopes downwards from the umbo, while the posterior is broad and rounded. The live larva appears a very pale yellow with the colour more intense on the dorsal anterior and posterior edges. The concentric lines, usually 10 in number, are quite distinct. A very few short bristles may be observed. The hinge apparatus is strong with about 16 large comb-like teeth which grow progressively larger from the mid-point outwards to the anterior and posterior of the hinge apparatus. The mid-point of the hinge apparatus bears no teeth and shows a gap.

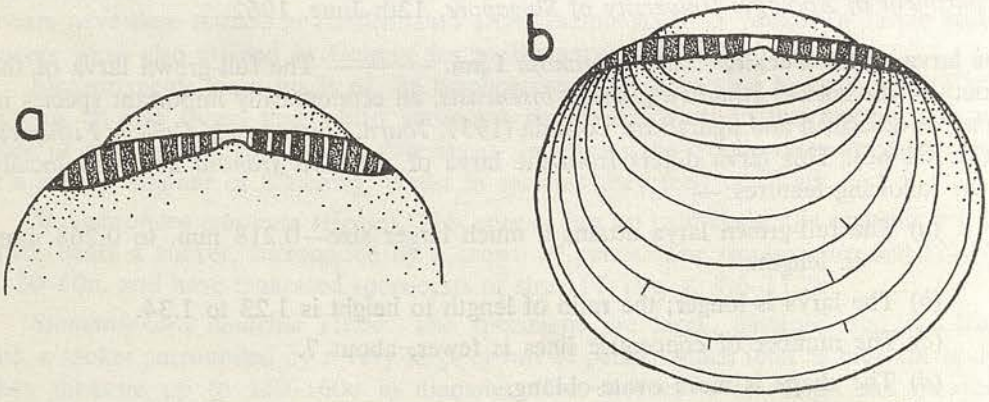


Figure 1. The larva of *Anadara granosa* Linn., (a) hinge apparatus, (b) lateral view.

The larva of *Anadara granosa* differs in the typical Arcacean characters of Rees (1950: 81, 83 & 89) in the anterior being the narrower end and in having fewer teeth which are similar in both valves.

I am grateful to Mr. Soong Min Kong, Director of Fisheries, Federation of Malaya, for his constant help and advice during the course of the present study. ——— D. PATHANSALI, *Fisheries Laboratory, Glugor, Penang,* 2nd August, 1962.

Some comments on the type specimens of Malayan fishes described by Georg Duncker. ——— In his account of the fishes of the Malay Peninsula, Ducker (1904, *Mitt. Naturh. Mus. Hamburg,* **21:** 133–207, 1 fig., 2 pls.) described 14 species and 1 subspecies as new. The type specimens were distributed between the Zoologisches Museum in Hamburg and the Selangor State Museum in Kuala Lumpur. The specimens in the Selangor Museum were believed to be entirely lost when the Museum was destroyed in 1945. However, while examining the Register of the fish collections in the British Museum in 1959, I noticed an entry dated 6th May, 1905 incorporating a small collection donated by Mr. H. C. Robinson who was then a curator in the Selangor Museum. Examination of these specimens revealed that they included a part of the type series.

In the course of preparing the third volume of their *Fishes of the Indo-Australian Archipelago,* Weber and de Beaufort (1916, p. vi) examined the Cyprinoid fishes in the Hamburg Museum, which included the Malayan material reported by Duncker. Some of these, including a few duplicates of Duncker's types, were retained in the Zoologisch Museum, Amsterdam.

Recently, Ladiges, von Wahlart and Mohr (1958, *Mitt. Hamburg Zool. Inst.,* **56:** 155–167) listed the types of 12 of the species, designating lectotypes and paratypes. The following notes supplement their list. The opportunity is also taken to correct the misspellings and clarify the abbreviations of the type localities given by them and by Duncker.

Osphromenus malayanus Duncker: 163, pl. 1, fig. 3. Ladiges et al: 166. Paratypes:—(2) BM. 1905.5.6.19–20, Kuala Lumpur, Selangor. Weber and de Beaufort (1920, *op. cit.,* **4:** 349) have already rediagnosed the species as *Sphaerichthys osphromenoides* Canestrini.

Nemachilus selangoricus Duncker: 175. Ladiges et al: 159. Paratype:—(1) BM. 1905.5.6.16, Kuala Lumpur, Selangor. It is not understood why Weber and de Beaufort (1916) make no mention of this species. It is also confusing that Ladiges et al. have listed the lectotype as *Botia selangorica.* The specimen I have examined is a species of *Nemachilus* Bleeker.

Barbus tetrazona var. *johorensis* Duncker: 178, pl. 1, fig. 3. Ladiges et al: 158. Paratype:—(1) BM. 1905.5.6.6, Muar River, Tebing Tinggi, Johore. I have rediagnosed the specimen as *Puntius pentazona johorensis* Duncker.

Barbus halei Duncker: 178, pl. 2, fig. 15. Holotype:— BM. 1905.5.6.7, Pahang River, Kuala Tembeling, Pahang. This is another species omitted in Weber and de Beaufort (1916).

Barbus soroides Duncker: 178, pl. 1, fig. 7. Ladiges et al: 158. Paratypes:—(3) BM. 1905.5.6.8–10, Eastern slope of Sangka Dua Pass, in the source zone of the Pahang rivers (about 2,000 feet above the sea), Pahang. Weber and de Beaufort (1916: 168) have rediagnosed the species as *Acrossocheilus dukai* (Day).

Barbus pahangensis Duncker: 179, pl. 1, fig. 4. Ladiges et al: 158. Paratypes:—(2) ZMA. 103213, (3) BM. 1905.5.6.11–13, Pahang River above Kuala Kitchal (88–120 km. above the river mouth). The specimens are juveniles of *Probarbus jullieni* Sauvage. Mr. J. J. Hoedeman allowed me to confirm the identification by dissecting one of the specimens for an examination of the pharyngeal teeth.

The locality "Kuala Kitchal" is not indicated in Duncker's map (p. 145) and I am not able to find it on other maps I have consulted. The stretch of the Pahang River 88 to 120 km. from its mouth is approximately between Kampong Chini and Kampong Kuala Jempol.

Barbus lineatus Duncker: 180, pl. 2, fig. 14. Ladiges et al: 158. Paratypes:—(1) ZMA. 103220, (2) BM. 1905.5.6.14–15, Muar River, Tebing Tinggi, Johore. This species also is omitted in Weber and de Beaufort (1916).

Rasbora vulgaris Duncker: 181. Ladiges et al: 159. Paratypes:—(2) BM. 1905. 5.6.4–5, Kuala Lumpur, Selangor. The species is correctly synomymised with *R. sumatrana* (Bleeker) by Weber and de Beaufort (1916: 77).

Rasbora maculata Duncker: 182, pl. 1, fig. 6. Ladiges et al: 159. Paratypes:—(5) ZMA. 103216, Bukit Terah, Bandar Maharani (=Muar), Johore. This is a valid species and Weber and de Beaufort have erroneously synomymised it with *R. kalochroma* (Bleeker).

Rasbora heteromorpha Duncker: 182, pl. 1, fig. 5. Ladiges et al: 159. Paratypes:—(3) ZMA. 103218, 2–3 milestone, Semenyih-Beranang Road, Selangor. In the original description, part of the type series was doubtfully assigned to Negri Sembilan. The remaining types were from Kuala Lumpur and the pond in the Botanic Gardens, Singapore. From the details on the labels of the specimens I have examined, I now find that the doubtful Negri Sembilan locality should be corrected to Selangor. The 2–3 milestone on the Semenyih-Beranang Road is approximately on the Sungei (= River) Rinching.

Brittan (1954, *Monogr. Inst. Sci. Tech. Manila,* **3:** 187) restricted the type locality to Kuala Lumpur. He did not examine any types. Ladiges et al. however, selected as the lectotype a specimen from "Semunga-Benung" (= Semenyih-Beranang). To clear up this confusion I sought the advice of Dr. L. B. Holthuis of the Rijksmuseum van Natuurlijke Historie in Leiden. His views on the prevalance of lectotype selection over type locality restriction were later confirmed by the secretariat of the International Commission who informed him (in litt.) that " it must be accepted that at present a designation of type-locality has no official status, as it is not regulated in the Code, and that therefore it may be overruled by a later lectotype designation."

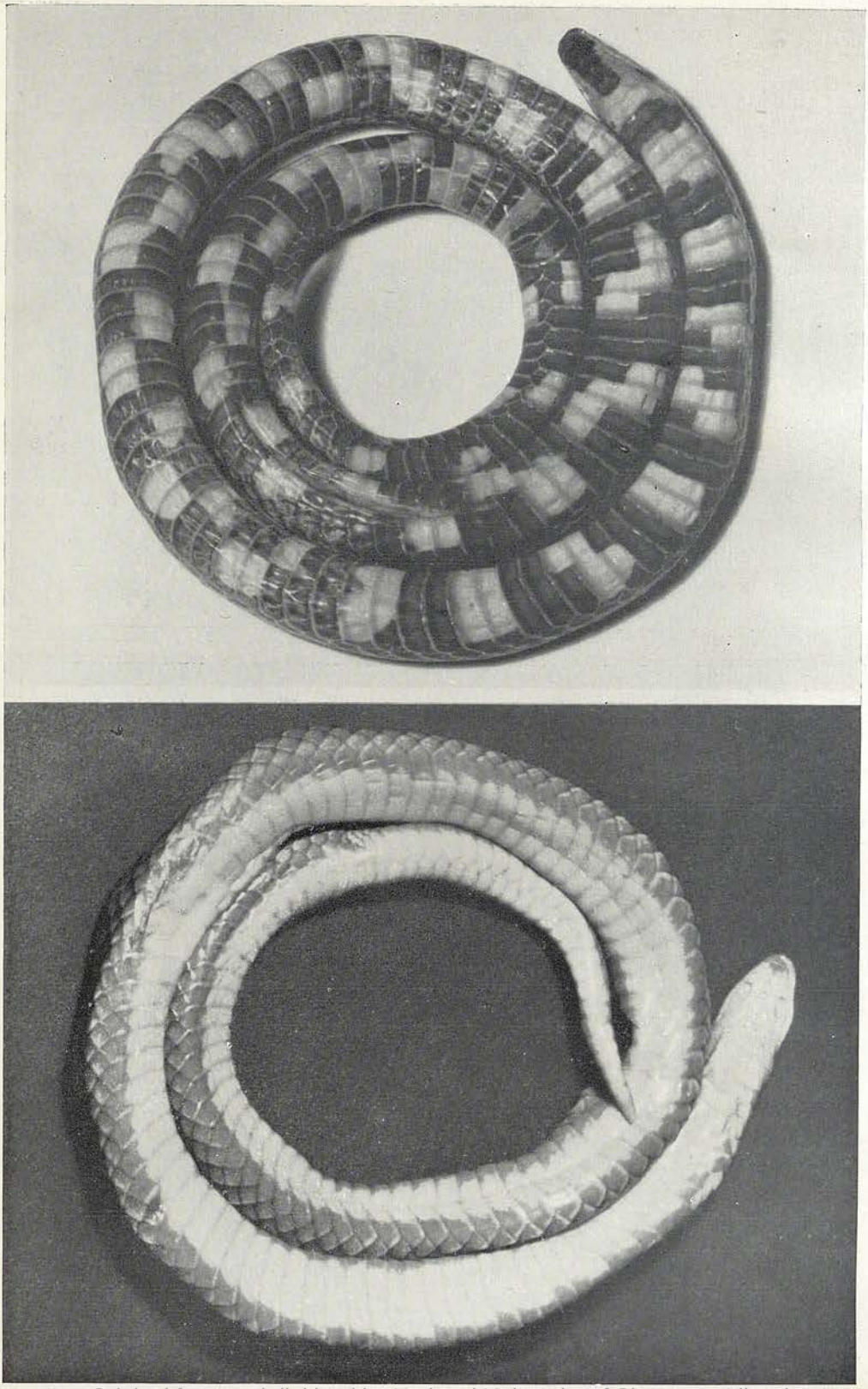
Rasbora dorsiocellata Duncker: 182, pl. 1, fig. 2. Ladiges et al: 159. Paratypes:—(3) ZMA. 103217, Muar River, Tebing Tinggi, Johore. The locality "Malacca" given by Weber and de Beaufort (1916: 68) should be corrected to "Malaya".

Pseudolaubuca (?) *clupeoides* Duncker: 183, pl. 1, figs. 1 & 1a. The Holotype and only specimen was deposited in the Selangor Museum and is now believed to be lost. It was not found among the specimens in the British Museum.

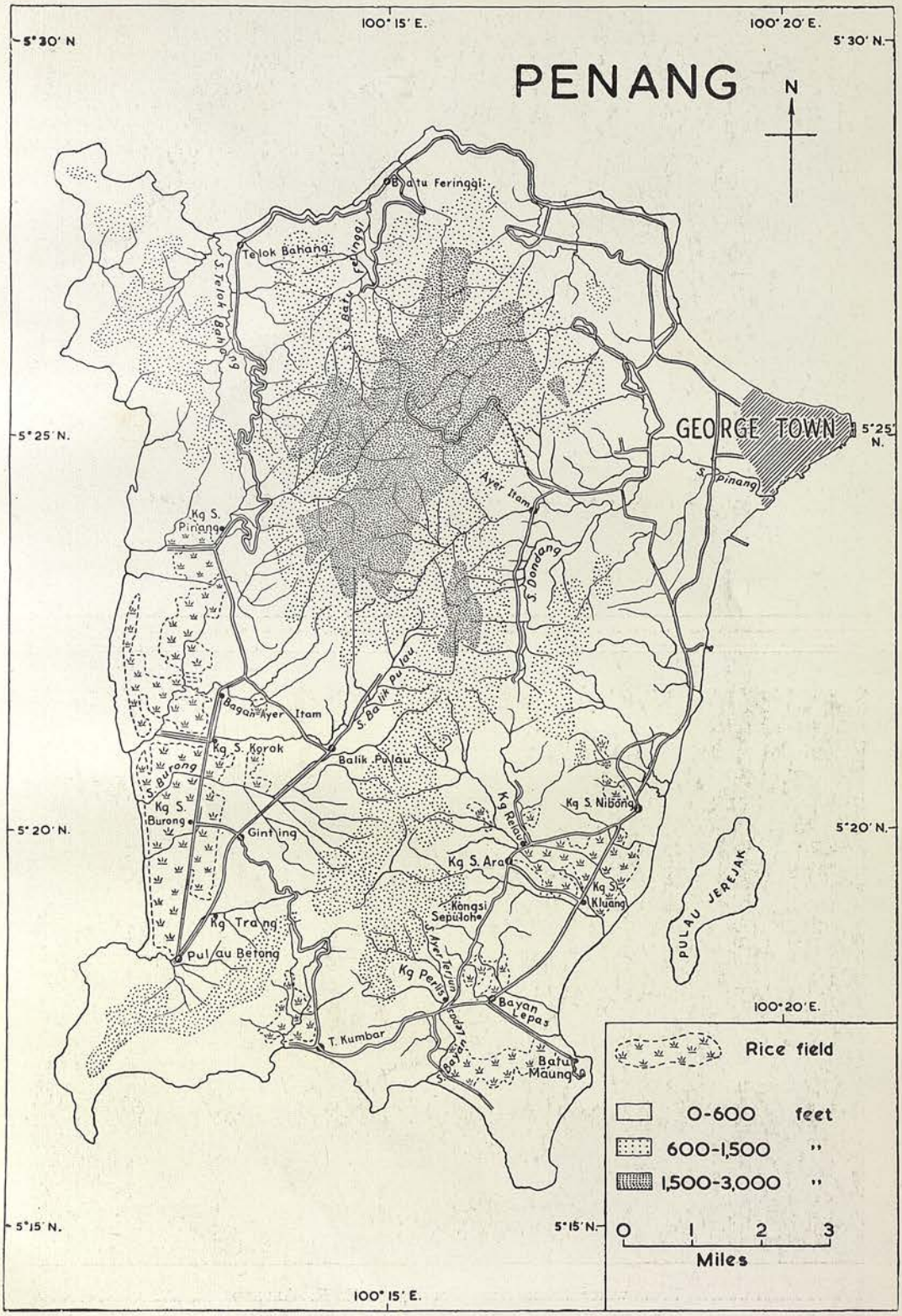
Dorichthys fluviatilis Duncker: 188, pl. 2, figs. 10 & 10a. Syntypes:—(2) BM. 1905.5.6. 17–18, Kuala Lumpur, Selangor. I agree with Duncker (1915, *Mitt. Naturh. Mus. Hamburg,* **32:** 53) that this is *D. deokhatoides* (Bleeker).

My thanks are due to Mr. J. J. Hoedeman formely of the Zoologisch Museum, Amsterdam and Messrs A. Wheeler and G. Palmer of the British Museum (Natural History), London for helping me to gain access to the specimens. ———— ERIC R. ALFRED, *Singapore National Museum,* 23rd January, 1963.

Colonization by Aquatic Insects C. H. FERNANDO



Macrocalamus tweediei sp. nov. B. L. Lim



Fresh-water fishes from Penang E. R. ALFRED

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